

FLOAT AND SKI OPERATIONS FOR ARMY AIRCRAFT



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FLOAT AND SKI OPERATIONS FOR ARMY AIRCRAFT

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*This manual supersedes TM 1-235, 8 November 1971.



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CHAPTER 1

PURPOSE AND SCOPE

1. Purpose

This manual provides the individual aviator with specialized detailed information on operating Army aircraft equipped with floats or skis.

2. Scope

This manual covers flight techniques for aircraft with twin-float installation, amphibious installation, or a combination of wheels and retractable skis (wheel skis). It also covers specific flight techniques, ground-handling techniques, special skills and knowledge required, and factors affecting flight performance.

3. Definition

A *seaplane* is an aircraft equipped for taking off or landing on water. This includes flying boats, twin-float seaplanes (floatplanes), amphibious floatplanes, float-equipped helicopters, and amphibious helicopters.

4. User Comments

Users of this publication are encouraged to submit recommended changes and comments to improve the publication. Comments should be keyed to the specific page, paragraph, and line of text in which the change is recommended. Reasons will be provided for each comment to insure understanding and complete evaluation. Comments should be prepared using DA Form 2028 (Recommended Changes to Publications) and forwarded direct to the Commandant, United States Army Aviation School, ATTN: ATST-CTD-D, Fort Rucker, AL 36360.

5. References

The information contained in this manual supplements the appropriate aircraft operator's or maintenance manual (TM 55-series). For details on float, amphibious, or ski operation for each Army aircraft, see the appropriate aircraft operator's manual. For details on fixed wing flight, see TM 1-250. For details on rotary wing flight, see TM 1-260.

CHAPTER 2

RULES, REGULATIONS, AND AIDS FOR NAVIGATION ON WATERS OF THE UNITED STATES

Section I. RULES OF THE ROAD

6. General

The Rules of the Road apply to all seaplanes operating on inland or international waters. From seaward at all buoyed entrances to estuaries of the United States, inland waters are inshore of a line approximately parallel with the general trend of the shore, drawn through the outermost buoy. The waters outside of the line are international waters or the high seas. For further details on the Rules of the Road, see TM 55-501.

7. Inland Rules

Seaplanes navigating inshore of the boundary line dividing the high seas from the inland waters must follow the established statutory Inland Rules of the Road and the regulations (Pilot Rules). Federal Aviation Administration Regulations 91.69 and 91.73 govern seaplane operations on inland waters of the United States.

8. International Rules

The US Coast Guard has jurisdiction over seaplanes operating on international waters. Seaplanes navigating outside the boundary line dividing the high seas from inland waters must follow the International Rules of the Road. All seaplanes must carry a current copy of CG-169 (app A) when operating in international waters.

9. Survival Equipment

On extended or sustained flight over bodies of water where forced landings on land cannot be negotiated, Army Regulation 95-1 requires that aircraft be equipped with sufficient lifevests, liferafts, and appropriate emergency survival equipment for each person on board. The Coast Guard recommends that liferafts be carried whenever possible when flying any distance from shore.

Section II. UNITED STATES AIDS FOR MARINE NAVIGATION

10. General

Locations of buoys within US waters are shown on nautical charts prepared by the US Coast and Geodetic Survey. Light Lists, prepared by the US Coast Guard, describe lightships, lighthouses, buoys, and daybeacons maintained on all navigable waters of the United States. For the US Coast Guard lateral system of buoys and daybeacons, see figure 1.¹ The buoyage system used in the United States employs a simple arrangement of colors, shapes, numbers, and lights. Buoy characteristics are determined by the location of the buoy with respect to the navigable channels as entered from a seaward direction. As all channels do not directly connect with the sea, pilots must consult navigational charts to determine the assumed seaward direction of the fairway. For additional essential information needed to understand the buoyage system of the United States, see CG-193, Aids to Marine Navigation of the United States, and

TM 55-501. For additional information essential to seaplane operations, see CG-169, Rules of the Road—International and Inland, and CG-172, Rules of the Road—Great Lakes.

11. Daytime Buoy Identification

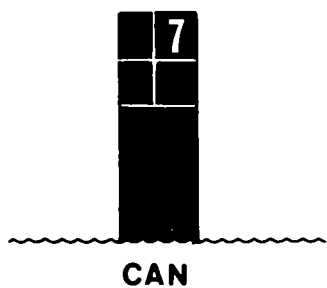
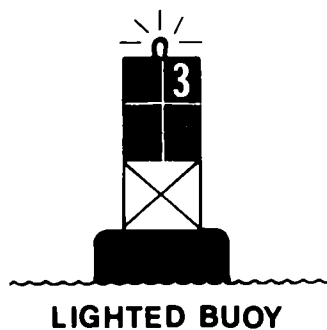
a. Types. When the color of a buoy cannot be determined, the shape may be valuable in determining the purpose of the buoy.

(1) *Spar buoy.* A spar buoy is usually a large log, trimmed and appropriately painted; it may also be constructed of steel plates joined to form a slim cylinder. The shape of a spar buoy has no significance. Coloring reveals the particular meaning of the buoy.

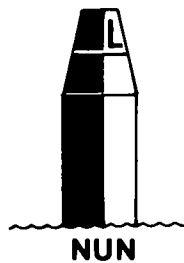
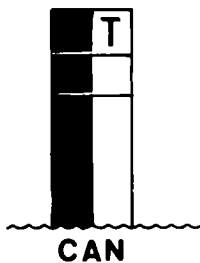
(2) *Can buoy.* A can buoy is usually constructed of metal and its shape is similar to that of an ordinary tin can. Solid-black painted can buoys (A, fig 1) designate the port side of a channel (entering from seaward). These buoys must be passed by keeping them on the port side. As indicated by the color

¹ From US Coast Guard publication *Aids on Navigable Waters Except Western Rivers and Intracoastal Waterway*.

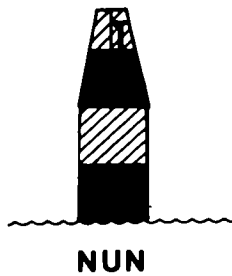
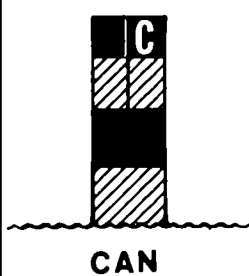
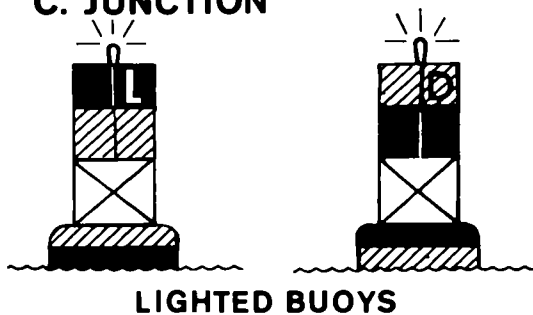
A. PORT SIDE



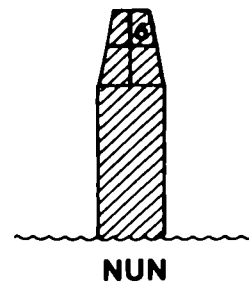
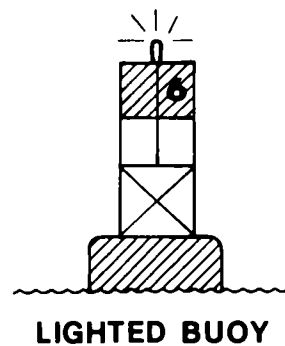
B. MIDCHANNEL



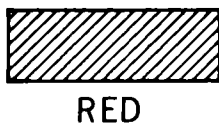
C. JUNCTION



D. STARBOARD SIDE



LEGEND



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Figure 1. United States system of buoys and daybeacons.

(c below), can buoys may also be used to mark the middle of a channel, a junction, or an obstruction.

(3) *Nun buoy.* A nun buoy is also constructed of metal and has a conical top. Solid-red painted nun buoys (D, fig 1) mark the starboard side of the channel. These buoys must be passed by keeping them on the starboard side. As indicated by the color (c below), nun buoys may also be used to mark the middle of a channel, a junction, or an obstruction.

(4) *Lighted buoy.* A lighted buoy is a float upon which is mounted a short skeleton tower with a lantern at the top. Its shape has no significance; however, its purpose is indicated by color.

(5) *Bell buoys, gong buoys, and whistle buoys.* These buoys are floats with sound equipment installed. No significance is attached to their shapes.

b. *Numbering or Lettering.* Buoys indicating the starboard side are marked with even numbers; those indicating the port side are marked with odd numbers. Midchannel and junction buoys are not numbered, but may be lettered for identification.

c. *Colors.* All United States buoys are painted with distinctive colors to indicate their purpose or the side on which they should be passed when entering from seaward.

(1) *Black buoy.* A black buoy (A, fig 1) marks the port side of a channel or the location of obstructions which must be passed by keeping the buoy on the port side of the floatplane. It displays white or green lights at night.

(2) *Red buoy.* A red buoy (D, fig 1) marks the starboard side of a channel or the location of obstructions which must be passed by keeping the buoy on the starboard side. It displays white or red lights at night.

(3) *Red and black horizontally banded buoy.* A red and black horizontally banded buoy (C, fig 1) marks a junction in the channel or an obstruction which may be passed on either side. If the topmost band is black, the preferred channel will be followed by keeping the buoy on the port side when proceeding from seaward; if the topmost band is red, the preferred channel will be followed by keeping the buoy on the starboard side. This buoy may have white, red, or green lights.

(4) *Black and white vertically striped buoy.* A black and white vertically striped buoy (B, fig 1) marks the fairway or midchannel and may be passed on either side. It displays a white light at night.

(5) *Special-purpose buoys.* Special-purpose buoys have distinctive colors and are usually spar

buoys. They reveal the locations of anchorage areas, dredging operations, etc.

12. Daybeacons

Daybeacons are unlighted structures other than buoys used as aids to navigation. In shallow water, a daybeacon may be a pile with a daymark or pointer at the top (A and D, fig 1). Daybeacons occupy a fixed position and thus have an advantage over floating buoys.

13. Nighttime Buoy Identification

a. *Colors.* Usually only buoys in key spots have lights; some unlighted buoys have reflectors which may be white, red, or green and have the same significance as lights of the same colors. Black buoys have green or white lights; red ones have red or white lights. White lights provide greater visibility and their purpose may be indicated by their light phase characteristics (b below). Midchannel buoys use white only, while obstruction and junction buoys use the appropriate color to indicate the preferred channel.

b. *Light Phase Characteristics.*

(1) Lights used to mark the port or starboard side of the channel may have fixed, occulting, flashing, or quick-flashing light phase characteristics.

(a) Fixed lights are not used on Coast Guard buoys but may be used occasionally on buoys by other agencies.

(b) Lights are occulting when the light period is equal to or longer than the dark period.

(c) Lights are flashing when the light period in the cycle is shorter than the dark period and the lights flash at not over 30 flashes per minute. Channel buoy lights are usually flashing.

(d) Lights are quick flashing when flashing at 60 or more flashes per minute. They are used to indicate caution. Channel buoy lights that mark important turns or dangerous areas will be quick flashing.

(2) Interrupted quick-flashing lights are used to mark a channel junction or obstruction. Interrupted quick-flashing lights are a series of quick-flashing lights with dark intervals of about 4 seconds. Red and black horizontally banded buoys have interrupted quick flashing lights—a series of quick flashes with dark intervals of about 4 seconds between series.

(3) Midchannel buoys have short-long flashing lights—groups consisting of a short flash and a long flash repeated at the rate of about eight per minute.

CHAPTER 3

SEAPLANE BASES

14. General

Figure 2 shows the symbol for a seaplane base. Lighted seaplane bases are indicated by alternating white and yellow flashes from a rotating beacon. Military seaplane base beacons are differentiated from civil beacons by dual-peaked (two quick) white

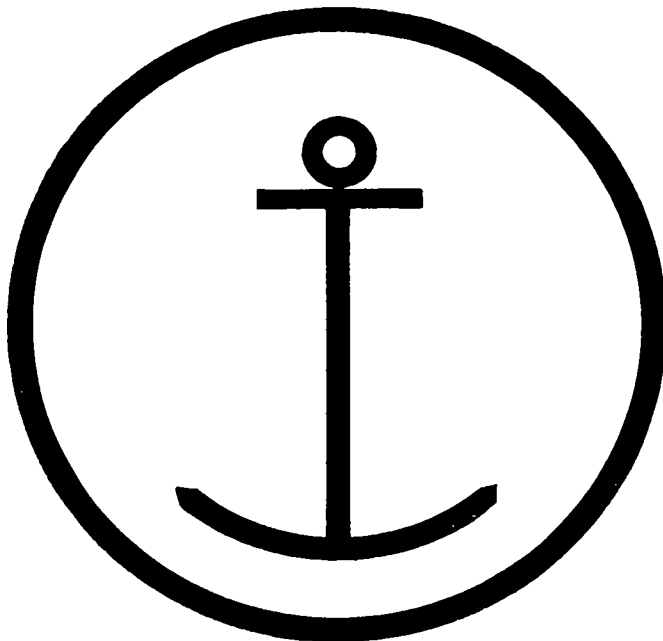


Figure 2. Symbol for a seaplane base.

flashes between the yellow flashes. Seaplane pilots should be familiar with the buoyage system that they may encounter in their area of operation.

15. Approach and Departure Paths

Seaplane base docking facilities (chap 8) should be located in sheltered waters, and, at the same time, afford clear approaches from as many directions as possible. Consequently each seaplane base is a compromise between these two conflicting requirements. The seaplane pilot can usually expect to find unfavorable approach or departure paths. Before approaching a seaplane base, the pilot should look it over thoroughly for obstructions such as buoys, boats, and floating debris.

a. The position and direction of motion of all boats in the vicinity should be noted. The direction of the wind and tide or current, if any, should be studied and the probable effect determined.

b. In approaching a base, a floatplane will tend to weathercock into the wind and it can always be turned into the wind without difficulty. Thus, if the floatplane is on the windward side of an object and clearance appears insufficient to pass, a turn away from the obstruction (or into the wind) may easily be made. On the other hand, ample room should be allowed when passing to leeward; for if the wind is strong and the floatplane swings, it may swing into the obstacle.

CHAPTER 4

ARMY AVIATION UNDER ARCTIC CONDITIONS ¹

16. General

Army aircraft equipped with conventional gear, wheel skis, or twin floats, offer an effective means of mobility in the Arctic. The Arctic includes non-forested areas of tundra, glaciers, grassland, semi-deserts, and the mountains above timberline. Each of the nonforested areas is distinctive in appearance and seasonal characteristics. For details of arctic operations, see FM 31-71.

a. Tundra. Tundra is a flat or gently rolling area having a muck to rock surface over permafrost and consisting of a low mat of grasses, shrubs, and other plants. This area is found above or north of the tree line. During summer, large areas of tundra resemble great plains. It is covered with a thick layer of hummocky moss interspersed with extensive marshes similar to those of temperate areas but usually not so deep because of the high permafrost table. The depth to the permafrost level will usually vary from 15 to 60 centimeters (6 to 24 in.). Tundra soils are extremely moist. During the winter and with some engineer effort, muskeg (*b* below) and tundra areas afford suitable landing sites to ski-equipped aircraft. A ground reconnaissance must be conducted to detect the presence of clumps of vegetation, rocks, and other hazards to landing. Movement of aircraft and ground handling of equipment is extremely difficult in these areas.

b. Muskeg. Muskeg is poorly drained organic terrain which is characteristic of the Subarctic. It is covered with a thick, resilient carpet of water-sodden mosses and tussocks, and underlain by a high water table, peat of variable thickness, and often permafrost. Helicopter operations in muskeg are hazardous because the basic design of landing gear offers no flotation. However, ski-equipped helicopters provide a more stable landing gear.

c. Glaciers. Snow-covered glaciers make suitable landing fields for ski-equipped aircraft. Ground reconnaissance should be made prior to landing. Crevasses, often hidden by snow, constitute a threat to any movement on glaciated terrain.

¹ Although arctic conditions are described, the techniques in this chapter are equally applicable to any area of the world that has snow and cold weather.

17. Frozen River Surfaces

Frozen river surfaces are not always dependable landing areas for ski-equipped Army aircraft. The thickness of surface ice (para 20) varies according to local conditions, including river depth and velocity, the existence of warm currents, range of previous duration of low temperatures, and other factors. In addition, ice movement makes the surface extremely rough and broken in many places. Points to consider for use of frozen rivers as landing areas are—

a. Immediately adjacent to the shore, the ice formation is thin and weak and more likely to develop cracks.

b. Where an underice current of water flows through a large area of ice, the ice in contact with the current is subject to greater variation of temperature in a given period of time than ice in the adjacent or surrounding areas.

c. Blue ice is generally quite thick. White ice is nearly always thin, especially on fast-flowing rivers.

d. Shallow water ice is usually thinner than deep water ice.

e. Sandbars will generally have weaker ice near their edge.

18. Frozen Lake Surfaces

Frozen lakes make excellent landing sites for ski-equipped airplanes and helicopters. Except for use as a hasty airfield, packing or removal of snow may be necessary before lake surfaces are usable. If extended usage is anticipated, parking ramps should be cleared of snow and paths provided for movement of heaters and auxiliary power units. Points to consider for use of frozen lakes as landing areas are—

a. Ice which appears cloudy or milky should be closely inspected for thickness and air pockets. The cloudy or milky condition is caused by gas or air being trapped within the ice. This type of ice may form over a lake or swamp (muskeg), which has decaying vegetation on its bottom.

b. Muskeg lakes contain much vegetation which retards freezing and results in weak ice.

19. Ice Floes

When ice floes are solid enough in winter, they can be used for landing skiplanes. Solidity of an ice floe can be judged from the air by the color of the ice.

Dark patches indicate near-surface water showing through. These patches make the ice floe too thin and unsuitable as a landing area. This color factor can also be used to judge the safety of frozen lake or river surfaces. The thickness of the ice above the water is another indication of the solidity of a floe. However, this thickness can vary from 8 to 25 centimeters (3 to 10 in.), depending on the type of ice composing the floe.

a. In a skiplane landing on either a floe or frozen lake surface, the pilot should take a quick look at his ski tracks when he first touches down and while he still has forward airspeed. Any discoloration of the tracks indicates a too thin landing surface, and the pilot must take off immediately. This may be accomplished by maintaining near takeoff speed after touchdown and performing an immediate takeoff after leaving a sufficient length of tracks across the

surface, then performing a low reconnaissance of the surface for any indication of discoloration. After the skiplane has come to a complete stop, skis should be observed before shutdown.

b. In a helicopter landing on either a floe or frozen lake surface, the helicopter pilot should start shutdown procedures only after he is sure that his landing surface is solid.

20. Required Ice Thickness for Support of Army Aircraft¹

The load carrying capacity of a floating ice sheet depends on ice thickness, temperature, structure, cracks present, underlying support, and resonance. The required ice thicknesses given in table 1 must be interpreted and modified as required by paragraphs a through f below.

Table 1. Required Ice Thickness for Support of Army Aircraft^a

Aircraft	Landing gear			Assumed gross weight (lb)	Fresh-water ice						Sea ice					
					Regular			Emergency			Regular			Emergency		
					Air temperature (° F.)						Air temperature (° F.)					
	14	22	31		14	22	31	10	19	28	10	19	28			
Required ice thickness (in.) ^b						Required ice thickness (in.) ^b										
Airplane—																
OV-1B, C, Mohawk.....	×			13, 500	12	13	15	8	9	11	17	21	25	14	17	19
OV-1D, Mohawk.....	×			18, 093	13	14	16	10	11	12	19	22	26	15	19	21
U-1A, Otter.....	×	×		8, 000	9	10	11	6	7	8	14	16	20	11	13	15
U-6A, Beaver.....	×	×		5, 100	8	9	10	5	6	7	12	15	17	10	12	13
U-8D, F, G, RU-8D, Seminole.....	×			7, 350	9	10	11	6	7	8	13	16	19	11	13	15
U-10D.....	×			3, 850	7	8	9	5	6	7	11	14	16	9	11	12
U-21A, G, RU-21A, D, E, Ute.....	×			9, 650	10	12	13	7	8	9	16	19	23	13	15	17
Helicopter—																
OH-6A, Cayuse.....			×	2, 400	5	6	7	4	5	6	9	11	13	7	9	10
OH-58A, Kiowa.....		×	×	3, 000	6	7	8	4	5	6	10	12	14	8	10	11
UH-1B, Iroquois.....		×	×	8, 500	10	11	12	7	7	8	15	18	22	12	14	17
UH-1C, D, H, M, Iroquois.....		×	×	9, 500	10	12	13	7	8	9	16	19	23	13	15	17
AH-1G, Cobra.....			×	9, 500	10	12	13	7	8	9	16	19	23	13	15	17
CH-47A, Chinook.....	×	×		31, 000	18	20	23	13	15	17	27	32	38	18	21	26
CH-47B, Chinook.....	×	×		40, 000	20	22	25	14	16	18	30	34	40	19	22	27
CH-47C, Chinook.....	×	×		46, 000	22	24	27	15	17	19	31	36	42	20	24	28
CH-54A, Tarhe.....	×	×		42, 000	18	20	23	13	15	17	27	32	37	21	24	28
Ch-54B, Tarhe.....	×	×		47, 000	19	21	24	14	16	18	27	32	38	21	24	29

^a Do not use this table without referring to paragraph 20.

^b Numbers have been rounded to the next higher inch.

a. Minimum ice Thickness.

(1) Since configuration of the loading surface is considered, the recommended ice thicknesses in table 1 are not in a simple relation to the gross weight.

(2) Gross weight is given on the basis of available information. If the gross weight is higher, 6 percent must be added to ice thickness for 10 percent weight increase; if less, 5 percent should be subtracted from ice thickness for 10 percent weight decrease.

(3) For safety in a given area of operation, the minimum ice thickness will govern the loading

criteria. This is especially important at the place of parking. Ice thicknesses can easily be checked with a US Army Cold Regions Research Engineering Laboratories ice thickness kit or equivalent.

(4) Ice thickness figures given for emergency landings involve some risk of breakthrough of the landing gear. Occupants of the aircraft should evacuate immediately. If possible, steps should be taken to move the aircraft or to apply floats to it.

¹ Acknowledgment is made to the US Army Cold Regions Research Engineering Laboratories, Hanover, New Hampshire, for the data prepared on ice thicknesses related to various ice conditions and the data on critical velocities.

(5) With minimum ice thickness, up to three landings a day can be made on an ice runway. As the ice thickness increases above the minimum, the number of landings can be increased. For example, if the ice thickness exceeds the minimum requirements by 10 percent, the number of landings per day can be doubled if they are spaced equally over a 12-hour period. When the "regular" ice thickness shown in table 1 is reached, the number of landings per day is unlimited; however, frequent inspections of the landing surface are required to detect deterioration or failures of the ice.

b. Temperature.

(1) Air temperature in table 1 is the average over the number of days preceding landing:

Ice thickness, inches—below 20	30–40	above 40	
Number of days-----	3	4	5

(2) If operations have to proceed under average air temperature higher than 31° F. on fresh-water ice and higher than 28° F. on sea ice, the required ice thicknesses given in table 1 have to be gradually increased by up to 20 percent more, until deterioration of surface conditions (e.g., slush) prevents further operation. In any case, operations must be suspended if maximum air temperature exceeds 40° F.

(3) Under regular operation, parking is allowable up to 1 hour. For 24 hours parking, the required ice thicknesses should be increased by 25 percent and the aircraft moved daily under low temperature conditions (below 10° F. for sea ice or 14° F. for fresh-water ice). Under medium temperature (19° F. or 22° F.), only 6-hour parking is allowed with 25 percent more thickness than required by table 1. Consider *a*(2) and *b*(2) above and *c*(2), (5), and (6) below. Parking near cracks should be avoided.

c. Structure.

(1) On ice fields which are subject to considerable lateral pressure and hummocking (pack ice), the required ice thicknesses should be increased by 10 percent.

(2) Occasionally, a field of pack ice will split. In some cases when this happens, the aircraft has to be taxied over the resulting lead using a temporary bridge. The supports of the bridge have to cover a reasonable area. The members of the bridge have to be sufficiently rigid to avoid excessive bending, which might result in a severe concentration of loading on the ice edge. Up to two times the usual ice thickness is required to avoid a breaking off of the loaded edge under these circumstances.

(3) It is assumed that snow is removed, except for 2 to 3 inches. When ice is covered by deep snow or when used less than 2 days after removal of deep snow, greater ice thickness is recommended.

(4) Sometimes a deep snowcover is penetrated by water. Landing on slush should be avoided. Over

fresh water, the slush period can be cut down by flooding; this can be accelerated by drilling holes in the ice as soon as slush in the lower snow layers becomes evident. Apply criteria under (5) and (6) below when the slush layer is frozen. Snow-ice (frozen slush) can be easily distinguished by its white color from the transparent black fresh-water ice. Snow-ice always has random, round air bubbles while the air bubbles in black ice are oriented in vertical lines. The identification of snow-ice on sea ice is not so easy. The round air bubbles are a sure sign of snow-ice; they should not be confused with small salt pockets (irregular margins) which can be seen in strong sea ice. Cold sea ice has a grayish appearance.

(5) In case of fresh-water ice where the snow-ice contains large air bubbles, only half of its thickness should be counted as effective thickness. If the air bubbles are very small and the snow-ice appears to be very solid, the total snow-ice layer should be counted as effective thickness.

(6) In case of salt water, only $\frac{1}{3}$ of the frozen slush layer (snow-ice) should be counted in the effective ice thickness during the first week after freezing, $\frac{1}{2}$ during the second week, and $\frac{2}{3}$ after the third week.

d. Cracks.

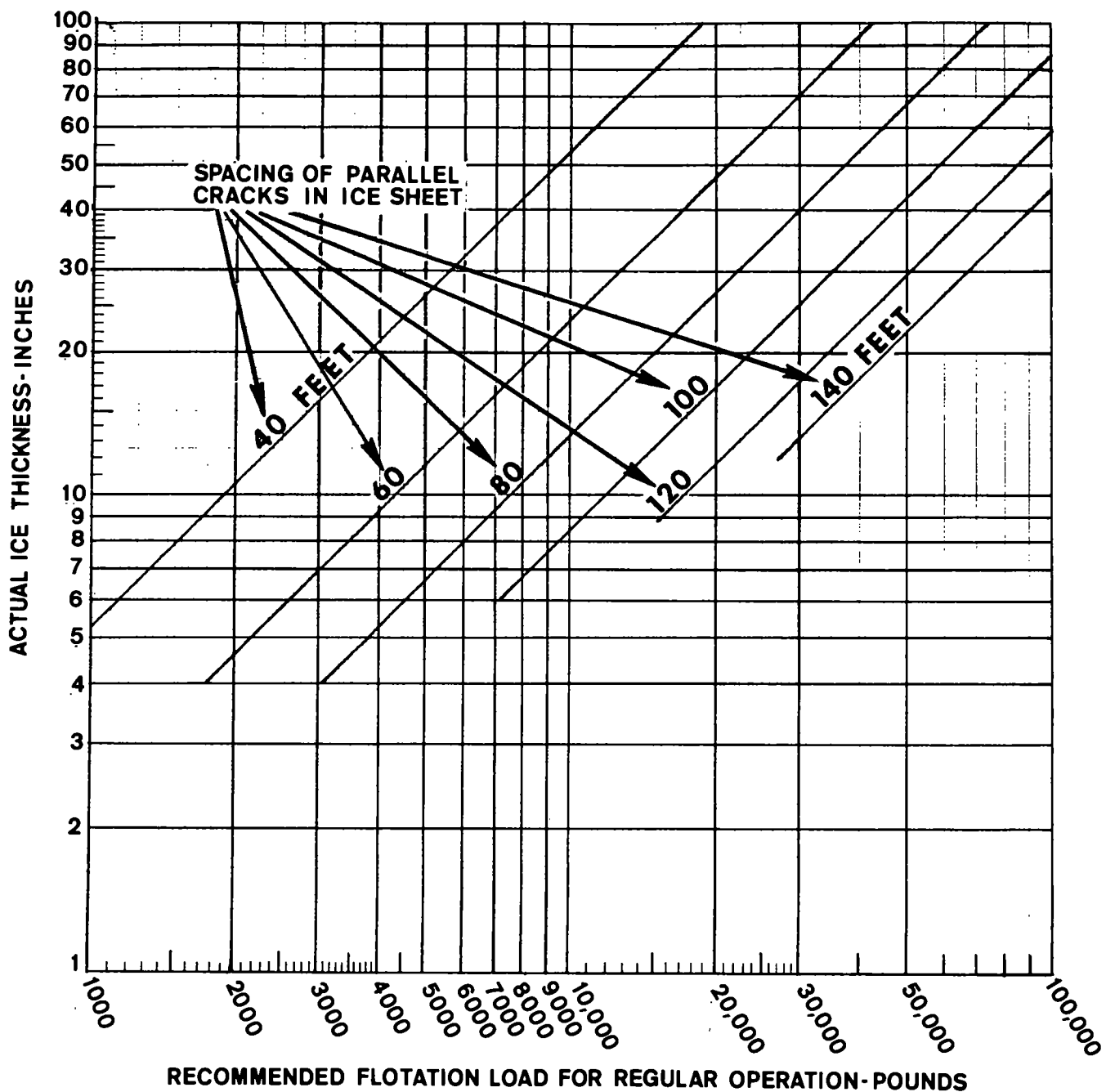
(1) Where the ice is cracked, required ice thickness for support of Army aircraft given in table 1 should be modified as in table 2. Either the ice thickness should be increased or the gross weight of the aircraft reduced.

(2) Aircraft should cross single wet cracks at right angles and should not roll over areas where several wet cracks intersect.

Table 2. Modifications to Aircraft Gross Weight or Table 1 Ice Thickness

Type of crack	Aircraft gross weight modification	Table 1 ice thickness modification
Hairline-----	None-----	None.
Refrozen-----	None-----	None.
Nonintersecting dry (up to 1 in. wide).	Use two-thirds weight.	Increase by 20 percent.
Intersecting dry (up to 1 in. wide).	Use one-third weight.	Increase by 70 percent.
Nonintersecting wet.	Use one-half weight.	Increase by 40 percent.
Intersecting wet---	Use one-quarter weight.	Increase by 100 percent.

(3) Where wet cracks are approximately parallel and have a spacing of one influence radius (table 3) or less for fresh-water ice or one-half influence radius or less for sea ice, the flotation capacity of the ice (fig 3) may govern. The load from figure 3 should be used only if it is less than the load from table 1,



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Figure 3. Safe flotation capacity of ice sheets with parallel cracks.

modified for cracks as indicated in (1) above. For emergency operation, twice the load given in figure 3 may be used.

e. Underlying support. Ice which is left unsupported because of a drop in a water level is of reduced strength. When testing the thickness of ice, it should be determined whether the water level beneath the ice has dropped.

f. Resonance. Under certain conditions, a taxiing aircraft will induce resonance waves in an ice sheet. These waves considerably increase the stresses in the

ice. Under marginal conditions, safety can be increased (and resonance avoided) by observing the following precautions:

(1) Avoid taxiing at the continuous speeds indicated in table 4.

(2) Avoid taxiing parallel to a shoreline at a distance of one load influence radius. Stay further away than two influence radii or nearer than one-half influence radius or land at an angle of 45° or more to the shore.

Table 3. Load Influence Radius

Ice thickness (in.)	Load influence radius (ft)
10	85
15	115
20	145
25	170
30	190
35	220
40	240
45	260
50	285
60	325
70	365
80	400
90	435
100	475

Table 4. Velocities at Which Resonance Will Occur, Based on Ice Thickness and Water Depth

Ice thickness (in.)	Water depth (ft)											
	5	10	15	20	30	40	50	60	80	100	150	200 or over
	Critical velocity (mph)											
5	9	12	14	15	16	16	16	16	16	16	16	16
10	↓	↓	15	17	19	20	21	21	21	21	21	21
15	↓	↓	↓	↓	20	22	23	24	24	24	24	24
20	↓	↓	↓	↓	21	23	25	26	27	27	27	27
25	↓	↓	↓	↓	↓	24	26	27	28	29	29	29
30	↓	↓	↓	↓	↓	↓	26	28	30	31	31	31
35	↓	↓	↓	↓	↓	↓	27	29	31	32	33	33
40	↓	↓	↓	↓	↓	↓	↓	↓	32	33	35	35
45	↓	↓	↓	↓	↓	↓	↓	↓	↓	34	36	36
50	↓	↓	↓	↓	↓	↓	↓	↓	33	35	37	38
55	↓	↓	↓	↓	↓	↓	↓	↓	↓	36	38	39
60	↓	↓	↓	↓	↓	↓	↓	30	↓	36	39	41
65	↓	↓	↓	↓	↓	↓	↓	↓	34	36	40	42
70	↓	↓	↓	↓	↓	↓	↓	↓	↓	37	41	43
75	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	41	44
80	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	42	45

21. Weather Hazards

Weather factors that must be considered in planning arctic operations include temperature, density, altitude, windspeed, wind direction, icing, visibility, turbulence, and forecasts. Flying conditions in northern areas (Arctic and subarctic) are normally good. Over the continental interiors, good flying weather usually prevails throughout the year. The cold temperatures greatly affect ground maintenance, but rarely interfere with an aircraft at flight altitude. Although the number of cloudy days during the summer will exceed the number of cloudy days during the winter, the summer months provide the best ceiling, visibility, and weather for flying. Frontal activity during the summer is weak and will very seldom cause severe turbulence, icing, or strong winds. Thunderstorms that develop during the summer months can usually be circumnavigated and do not

greatly interfere with operations. From the end of the spring breakup period until early winter, offensive operations which require long-range mobility will be dependent for the most part on air movement. Seasonal operating conditions are—

a. Winter. Snow cover blankets many terrain features and acts as a thermal insulator which retards the freezing or thawing of underlying ground. When snow melts, it saturates the ground and often makes it impassable. Snow increases maintenance requirements on airfields since it requires removal or compaction. Wheeled aircraft should not land on uncompacted snow deeper than one-third of the wheel diameter. Snow banks should not be allowed at the end of runways. When landing on ice, the height of snow banks at the sides of the runways should not exceed two-thirds of the ice thickness.

b. Spring Breakup Period. The spring breakup period may occur suddenly. Its duration varies from 1 to 6 weeks, depending on regional and local climatic conditions. This is the period of spring thaw when the group surface becomes excessively wet and soft and ice disappears from rivers and lakes. Operations may have to be suspended during the spring breakup period.

c. Summer. During summer months, the northern regions are characterized by an abundance of open lakes, rivers, and muskeg. Float-equipped or amphibious aircraft can use lakes and rivers for landing areas. During summer operations in muskeg, the surface condition must be firm enough to prevent helicopters from bogging down. Ski-equipped helicopters should be used when landing in muskeg (para 16b).

d. Freezeup. During the freezeup period, the ground surface freezes and ice cover forms on rivers and lakes. This period varies from 1 to 3 months depending on regional and local climatic conditions. Operations can be resumed as the period progresses.

22. Visibility

Snow, clouds, fog, heavy rain, and whiteout are northern weather conditions which frequently render flight impossible.

a. Over the Arctic Ocean and along the coastal areas, the main hazards to aircraft operations are blowing snow and strong surface winds during the autumn and winter, and fog during the summer. Blowing snow is hazardous in all operations, but especially in hovering operations. This restriction to visibility may be deceptive to the inexperienced pilot because the shallowness of the layer of blowing snow usually permits good vertical visibility at the same time that the horizontal visibility is very poor within the layer. It can be minimized by disturbing the surface and allowing it to refreeze or consolidate. After

consolidation the snow will crust and form a hard surface.

b. Except for cold temperature and regular water-droplet fog, ice fog is the major restriction to aircraft operation in the winter.

(1) During cold weather, ice crystals result from the sublimation of water vapor and are a form of precipitation. Their concentration is seldom so dense that the horizontal visibility rarely falls below 5 miles. However, prevailing ice crystals can rapidly produce much more dangerous ice fog by the mere operation of an aircraft engine. When landing at an airfield reporting ice crystals, a minimum of low flying and normal approach is recommended.

(2) Ice fog is a heavy concentration of ice particles forming on nuclei in the air. It constitutes a serious problem because of its infrequency of occurrence and its tendency to persist for extended periods. It is a local condition associated with industrial areas and heavy vehicular traffic. Normally, it occurs at temperatures of -37°C . (-35°F .) or lower, but may occur at temperatures as warm as -29°C . (-20°F .). Below -34°C . (-30°F .), ice fog requires instrument approaches and departures. Visibility in ice fog may be reduced to almost zero at ground level; however, the fog does not usually rise above 30 meters (100 ft). Extreme caution should be used when consulting weather reports during periods conducive to the formation of ice fog. Prevailing visibility above the fog is usually reported in the sequence report, while runway visibility in the fog is given in the remarks section. Visibility above the fog is generally unlimited.

(3) Under certain atmospheric conditions, propeller wash, rotor systems, and combustion products from an aircraft engine can provide the disturbance and nuclei to fog a landing field to a height of approximately 15 meters (50 ft). Horizontal visibility may then be down to a few hundred feet, while downward visibility is generally adequate. At night, glare will be reduced if landing and navigation lights are left OFF. Ice fog frequently takes from 15 to 30 minutes to dissipate after aircraft takeoff. Ice fog does not cause icing of aircraft because no water droplets are present.

c. Along the Arctic coast during June, July, and August, fog occurs on an average of about 20 days each month. When the temperature is below freezing, the fog becomes a potential source of icing. Caution is required when operating an aircraft in fog when the temperature is between 0°C . (32°F .) and -29°C . (-20°F .).

d. High winds and the phenomenon of whiteout can interfere with aviation operations. Whiteout is a condition of visibility that exists when an overcast sky prevents shadows and snow-covered terrain reflects light at about the same intensity as the sky,

causing the horizon to be indistinguishable and the recognition of irregularities in terrain very difficult. Only dark objects can be seen. Fog, ice fog, and blizzard conditions will sometimes create a similar situation.

e. Thin mist may often occur in the subarctic when the sun does not dissipate fog and low clouds.

(1) Vertical visibility remaining good, the horizontal visibility is poor. The formation of ice and frost should always be anticipated under these conditions.

(2) Blowing snow may obscure the landing strip and make a safe landing doubtful. In blowing snow, landing lights should be left OFF during night landing.

23. Icing

Only those aircraft equipped with deicing equipment are capable of safe instrument flight into clouds or visible moisture when the temperature is freezing or below.

a. Takeoffs should not be attempted when frost, ice, or snow is on the wings. Even a thin layer of snow may not blow off; and only a thin layer is necessary to cause loss of lift, hence influencing flight characteristics. When aircraft are left outside during extreme cold, hoarfrost may form on the wings. This should always be removed before operating the aircraft. Also, after prolonged storage or after a blizzard, windblown and packed snow may have entered the wings, control surfaces, or other void spaces; thus seriously affecting weight, balance, and control movement.

b. Wing and rotor covers are essential to northern winter operations if time involved in removing snow, ice, and frost is to be avoided. Covers serve a secondary camouflage purpose when they are colored to blend with the background.

24. Effect of Low Temperatures on Aircraft and Equipment

Low temperatures adversely affect aircraft and equipment, fuel, and oil as follows:

a. *Flight and Engine Instruments.* Expect vacuum operated flight instruments (directional gyro, turn and bank indicator, and artificial horizon) to be unreliable because of bearing friction caused by congealed lubricants. Heaters keep flight and engine instruments at operating temperature. Should heater failure occur during flight, the aircraft commander must evaluate the necessity of continuing the mission under the prevailing conditions.

b. *Plastics.* Plastics become brittle and may crack when the aircraft is moved from a warm hanger to an outside dispersal point. Therefore—

(1) Look for small cracks at edges of mounting frames or at small radii on curved panels.

(2) Check cockpit windshield carefully as cracks may lead to disintegration in flight.

(3) Handle doors with caution.

c. Synthetic Rubber. Synthetic rubber of certain types used in flexible oil and fuel lines and for coating electrical cables may lose flexibility. To prevent cracking of material, bending should be avoided.

d. Control Cables. Control cables tensioned inside a hanger become slack as the airframe contracts more than the steel cables with a given temperature drop.

e. Batteries. Batteries lose as much as 50 percent of their charge at -18°C . (0°F .) and cannot be charged at normal rate. Therefore—

(1) Leave only fully charged batteries outside. They will not freeze, but their usefulness is very limited.

(2) If forecast temperature is below -30°C . (-22°F .), keep batteries in a warm place to ensure use when required.

Note. If batteries are not fully charged and left outside, there is danger of freezing of the electrolyte and splitting of the battery case.

f. Tires. Tires on dispersed aircraft may stiffen with a flat spot frozen on them. This flat spot will disappear when the aircraft is taxied. However, in extreme cold (below -40°F .), tires may freeze to the surface and the tread may tear off when moved. This can be prevented by parking the aircraft on dunnage or similar material (para 103).

g. Hydraulic and Pneumatic Leaks. Hydraulic and pneumatic leaks may appear more frequently. As small leaks or seepage will usually disappear with increasing temperatures, it should be decided whether corrective action should be taken.

h. Snow and Frost. Snow and frost can be brushed off the exterior of aircraft without difficulty. Snow should always be removed from aircraft when a thaw is forecast in order to prevent later freezing.

i. Ice. Ice may require heat for its removal, making it necessary to—

(1) Fit covers on aircraft removed from a warm hangar during precipitation.

(2) Fit blanking plates to air intakes after shutting down.

(3) Watch for ice, in the vicinity of fuel tank vents, caused by condensation.

(4) Remove ice or snow from the inside of the propeller spinner as resulting unbalance may cause dangerous vibration.

j. High Static Charges. High static charges can develop during removal of snow or ice. Since the fuel/air mixture which is produced when gasoline evaporates at temperatures from -10°C . (14°F .) to -40°C . (-40°F .) is explosive, refueling presents a much greater fire hazard in very cold weather.

Therefore it is recommended to—

(1) Electrically ground aircraft as well as possible.

(2) Wait for 30 minutes for electric charge on rubber and plastic parts to leak off.

(3) Make sure that charges built up in the bodies of the refueling crew are discharged by having them touch a metal surface with bare hands. (Wipe moist hands dry, as moist skin will stick to the metal instantly.)

(4) JP-4 fuel greatly reduces the explosive hazard during refueling operations; however, above procedures should still be followed.

k. Fuel in Drums. Fuel in drums from a cache necessitates the following precautions:

(1) Always filter fuel from drums.

(2) If part of the fuel has been used from a drum, do not use the remaining fuel as it may be contaminated.

Note. The octane value of cached fuel may be lower than marked as fuel slowly deteriorates in storage.

(3) Check fuel octane color code by pumping some fuel on the snow.

l. Short Engine Runs. Engine runs should be long enough to bring the engine up to operating temperature. If run for a shorter period, water vapor in combustion products escaping past the piston will condense inside the crankcase and be distributed through the oil system. Split oil coolers, blocked oil lines, and possible engine failure may be the result. Avoid short engine ground runs.

25. Floating Dock Facilities

Floating dock facilities can be provided by making good use of field expedient measures adapted to the particular conditions of environment and operation.

a. Site Selection. When constructing floating dock facilities, considerations for selecting a site should be—

(1) Water.

(2) Obstacles.

(3) Approach and departure routes.

(4) Predominant wind direction.

(5) Accessibility to support facilities.

b. Operations. Crew chiefs and floating dock handling personnel should be thoroughly briefed on the following items:

(1) On water, floatplanes are subjected to varying wind directions and velocities and they react differently in dock handling.

(2) Since aircraft enter the docks at different water speeds, well-planned action is required to prevent float and/or aircraft damage.

(3) Padded pike poles at least 12 feet in length, large bollards, coiled line (50 ft long), and a mini-

mum of three dock helpers are required for securing aircraft safely.

(4) Spacing between aircraft for mooring and docking must be at least twice the wingspace distance. This distance increases in areas of fast-flowing water or high wind velocity.

c. Maintenance. Maintenance of floatplanes on water is difficult because of inaccessibility of components. When necessary, aircraft may have to be moved to another location to ensure that all required accessories and aircraft components are thoroughly inspected. Due to prolonged high manifold pressures and rpm while operating floatplanes, powerplant maintenance increases. Particular attention should be given to intercyylinder baffles and exhaust collector systems. High exhaust manifold temperatures and inherent airplane vibrations induced by floatplane op-

erations increase maintenance problems. During periods of cold temperatures, high winds, and snow and ice, maintenance requirements and time for maintenance are increased.

(1) Loss of tools and items removed from floatplane can be prevented by placing canvas covers and prefabricated platforms under the area of the floatplane where the mechanic is working.

(2) A mechanic working over water may secure his tools by attaching them to light twine tied to the aircraft or dock. Twine should be long enough to allow freedom of movement.

(3) Floatplanes must be lubricated in accordance with the appropriate organizational maintenance manual. The use of the zinc chromate and paralketone on exposed cables and float accessories lowers maintenance problems.

CHAPTER 5

BASIC RULES AND PRINCIPLES FOR FLOATPLANE OPERATIONS

Section 1. INTRODUCTION

26. General

The floatplane has a strong tendency to weathercock into the wind when on the water (para 38*a* and *b*). The pilot must always be aware of this tendency and learn to use or counteract it through the proper use of the controls. In an appreciable crosswind or tailwind, he must maintain positive control of the floatplane to prevent veering from the intended course. Special pilot techniques for the Army's U-1A (Otter) (fig 4) and U-6 (Beaver) single-engine floatplanes, without reversible propeller, are discussed in this chapter.

27. Floatplane Description

Basically a floatplane is a conventional airplane on which the wheel landing gear has been replaced by a pair of floats (*pontoons*) to provide buoyancy in water. Floats must be lightweight and strong with aerodynamic design for optimum performance in air and water. They are usually constructed of a light, tough aluminum alloy with parts riveted together. Provision is made on each float for fitting a beaching gear. Figure 5 shows a typical float with basic parts nomenclature. For a detailed description of floats, see technical manual on maintenance instructions for the aircraft and appropriate manufacturer's technical instructions.

a. The float gear (fig 6) is attached to the fuselage by struts (usually three on each side) and diagonal bracing wires. The attachment fittings allow flexibility for absorbing shocks and stresses in rough water.

b. A pair of transverse struts (spreader bars, fig 6) and diagonal bracing wires hold the floats in parallel alignment.

c. The V-shaped bottoms of the floats provide cushioning on the water without shock absorbers.

d. The step is located slightly more than halfway back from bow to stern of each float bottom. It reduces drag at planning speeds.

e. The skeg is installed just aft of the main step on each float as part of the keel. On land, the skeg protects the bottom of the float and prevents the floatplane from tipping back.

f. For taxiing control, a retractable water rudder is installed at the stern of each float.

g. A rubber bumper is fitted to the front end of each float for protection during mooring and against floating obstacles.

h. To localize flooding in case of damage, bulkheads are used to divide the floats into watertight compartments. Bilge pump openings on the float deck provide drainage for each compartment. Each opening is covered by a handle-screw cap (fig 6).

28. Amphibious Floatplane Description

An Amphibious floatplane is a conventional airplane on which the wheel landing gear has been replaced by amphibious floats. Amphibious floats permit routine flights from airfield to airfield, water to water, airfield to water, and water to airfield.

a. Each amphibious float is equipped with a retractable water rudder and a retractable main wheel and nosewheel.

(1) The water rudders are retracted and extended through a system of cables and pulleys and steered through the rudder pedals.

(2) The main wheel retracts directly upward into a well located aft of the step on the bottom of each float.

(3) The nosewheel retracts forward to a position over the bow of each float into a well in its upper deck. It automatically locks in a trailing position when the floatplane becomes airborne so that, on retraction, the wheel enters the well without fouling its edges. When the wheels are extended (*c*(2) below) and are supporting the plane on the ground, this automatic lock is disengaged and the nosewheels swivel to facilitate maneuvering during taxiing and ground handling.

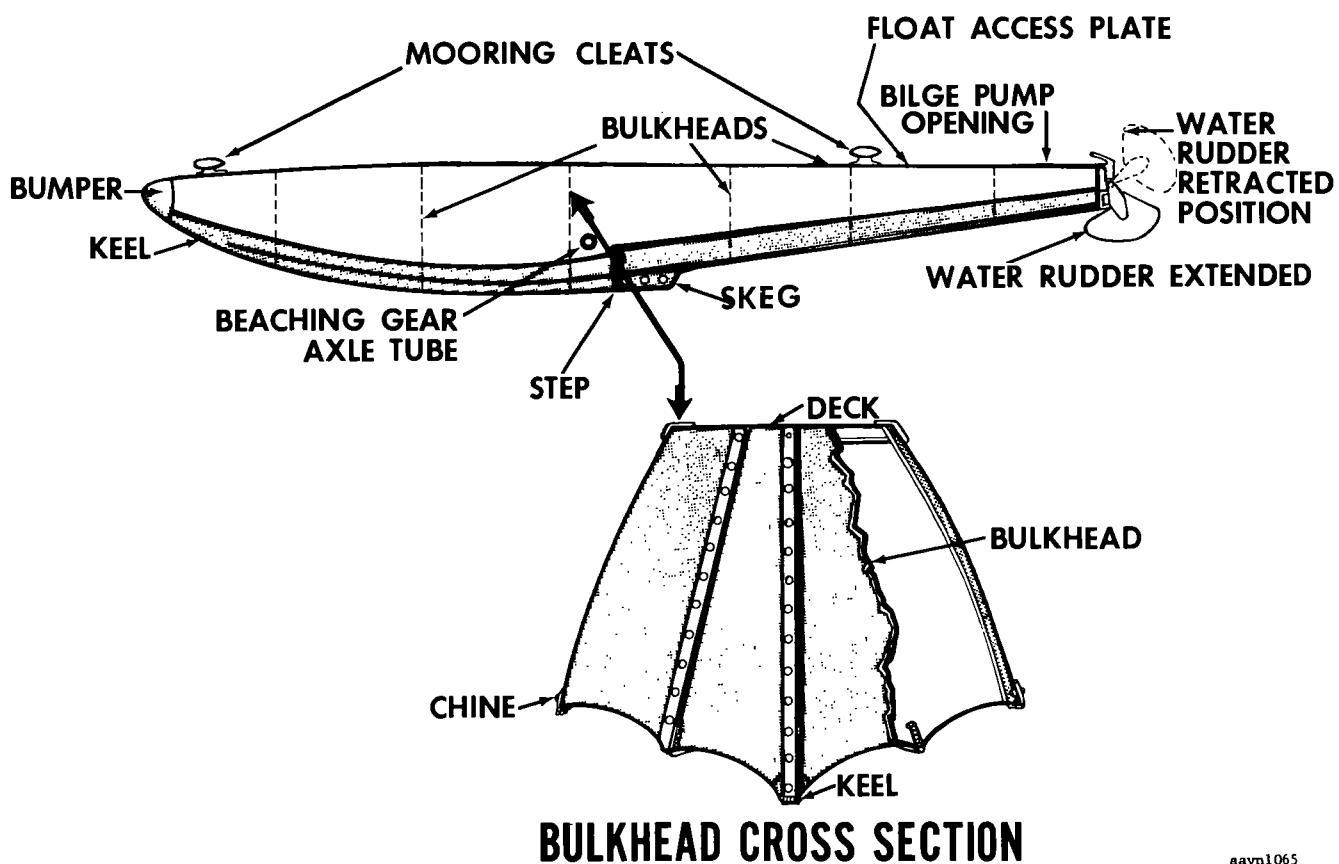
b. Retraction or extension of the wheels is accomplished by hydraulic pressure from a manually operated hydraulic pump. This hydraulic pump and a selector valve form a hydraulic control unit (fig 7), located on the cockpit floor.

c. When all wheels are fully retracted, an electrical wheels position indicator displays the word *UP*; when fully extended and locked down, it displays a wheel.

(1) When the wheels are in transit between the *UP* and *DOWN* positions, a diagonal red and white lined pattern is displayed. This pattern will also be



Figure 4. U-1A floatplane



aavn1065

Figure 5. Details of float construction.

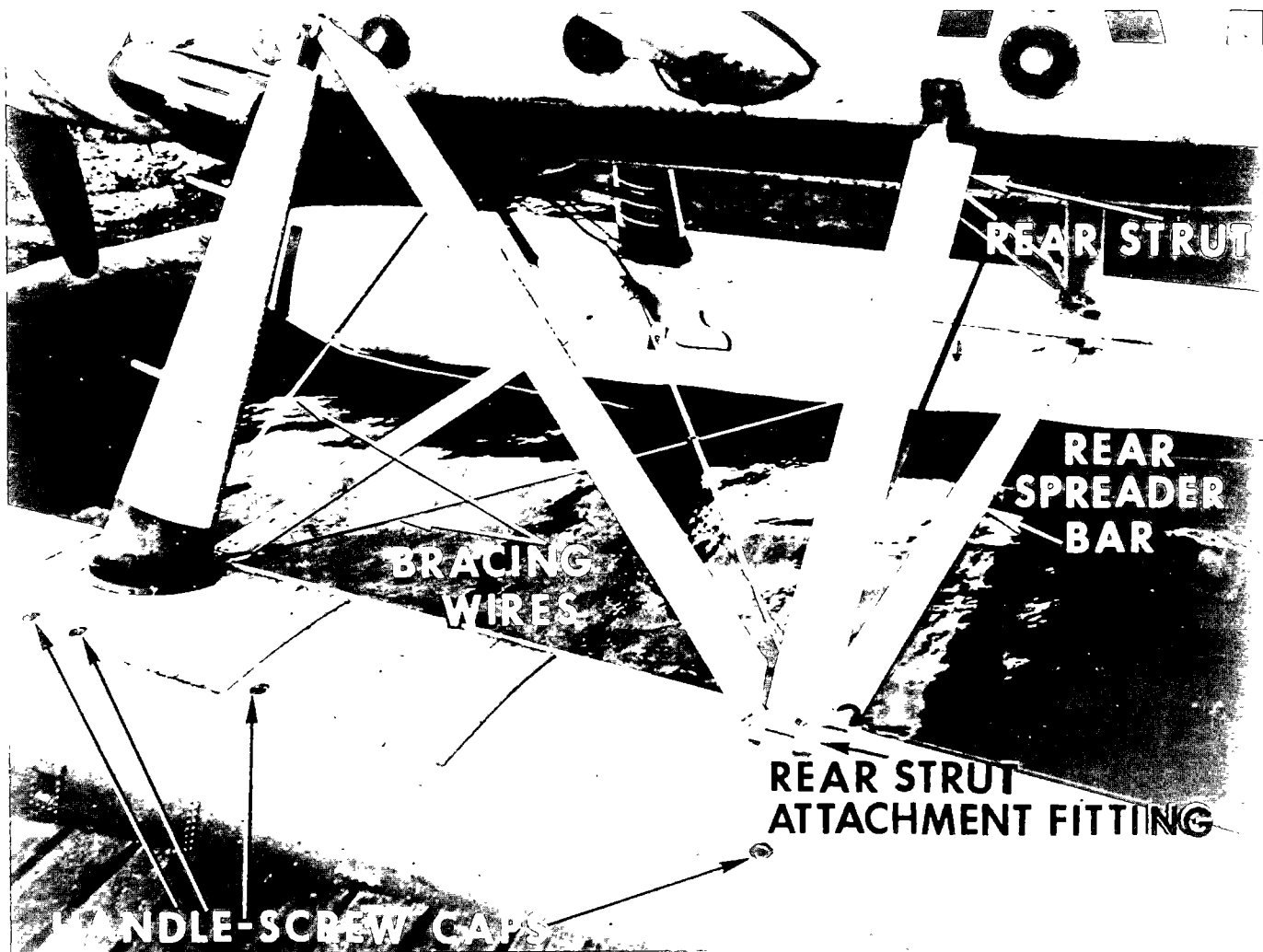
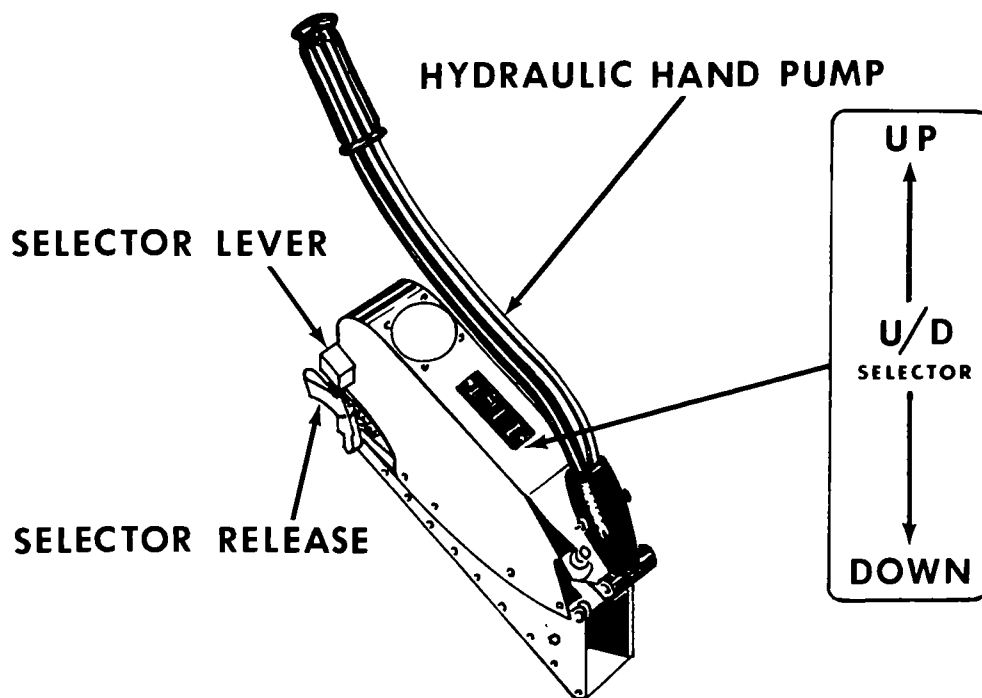


Figure 6. U-1A float gear.



aavn1069

Figure 7. U-1A hydraulic control unit.

displayed when the electrical circuit is broken or the toggle type circuit breaker is at the OFF position.

(2) The main wheel brakes are connected to the normal brake system. When the wheels are extended for landing on land, the main wheel braking system is operated hydraulically through actuation of the rudder toe pedals. When taxiing on an airfield, application of the toe brake pedals will aid steering.

29. Float Hydrodynamics

The upward force on a float is equal to the weight of the volume of water displaced by the float. The center of buoyancy (fig 9 and 10) is the upward force that acts in a vertical axis at the center of gravity of the displaced water. If a floatplane is floating on calm water, a line drawn around a float at the water surface is called the *waterline*. Displacement is generally expressed in terms of weight. Normal displacement is the weight of the water that would be contained in the floats up to the waterline. Reserve displacement is the weight of the water required to fill the float above the waterline.

30. Floatplane and Landplane Operation Compared

While airborne, the floatplane flies and maneuvers much like a landplane. On the water in an appreciable crosswind or tailwind, the pilot must maintain positive control of the floatplane to prevent veering from the intended course.

a. Floats slightly increase lateral stability. This effect becomes most apparent in the slower rate of rotation in spins. (Intentional spins are prohibited in the U-1A and U-6A.)

b. Because the floats project well forward of the center of gravity and cancel part of the weathercocking effect designed into the landplane, directional instability is a common result. However, this increased yaw is offset by the addition of auxiliary vertical fins. On the U-1A (fig 4) and U-6A floatplanes, ventral fins are placed beneath the vertical stabilizer on the undersurface of the fuselage where it replaces the tail gear.

c. Detailed comparisons of Army floatplanes and landplanes are found in the performance data given in the appropriate operator's manual. For example, table 5 gives comparative performance data for the U-6A landplane and floatplane. The landplane and twin-float floatplane figures are based on a maximum

gross weight of 5,100 pounds, zero wind, and sea level standard atmosphere. Due to the decreased buoyancy of the amphibious floats, however, the maximum gross weight of the U-6A amphibious floatplane must not exceed 5,000 pounds.

d. The extra weight and drag of the floats slightly reduce speed, range, useful load, and rate of climb. If the floats become partially filled with water, performance characteristics are further reduced. For example, 12 gallons of water add about 100 pounds to the takeoff weight.

Table 5. U-6A Landplane and Floatplane Comparative Performance Data

Item	Landplane	Floatplane	Amphibious floatplane	
			On land	On sea
Takeoff distance	815 feet	1,220 feet	865 feet	1,220 feet
Rate of climb...	835 fpm	785 fpm	735 fpm	735 fpm
Landing distance	590 feet	890 feet	685 feet	890 feet
True airspeed...	109 knots	101 knots	101 knots	101 knots

e. In addition to the checks for landing a landplane on land, the pilot must ensure that the wheels are selected DOWN and that the indication on the hydraulic control unit indicator is a wheel. Before starting to taxi, he checks that the water rudders retraction handle is in the UP position. As soon as the amphibious floatplane starts moving, he tests the brakes. Although the amphibious floatplane is in a quadricycle undercarriage configuration giving better taxiing visibility, more care should be taken to avoid rough or uneven ground in order to avoid damage to the floats. Furthermore, when maneuvering, the pilot must keep in mind the additional area required for the length of the floats.

f. When flying IFR through icing conditions, the floats, struts, and brace wires will also be subject to ice accretion, causing more weight and drag than experienced in landplanes. The U-1A floatplane has a mechanical disconnect when water rudders are retracted and the U-6A floatplane has springs in the rudder control circuit which permit continued air rudder operation if the water rudders become frozen.

g. The handling of a floatplane on the water and during the takeoff is very different from taxiing and taking off a landplane.

Section II. INSPECTIONS AND PROCEDURES

31. Daily Inspections

a. Floats should be inspected daily for leaks and damage. They should be examined for leaks while in the water, or just after beaching before the water can drain out through the leak. A cupful of water

per compartment may be attributed to normal seepage; any more should be investigated.

b. Float bottoms should be checked for dents or deformity; bulkheads between compartments for cracks or buckling, especially after a hard landing;

struts, guy wires, and attachment fittings for condition and security; and water rudders and their operating cables and linkages for condition and freedom of movement.

c. Wires should be inspected for snugness and no lost motion. Insufficient movement seriously reduces the effectiveness of control.

32. Preflight Inspection

In addition to making the normal aircraft preflight inspection and flight plans prior to the flight, the floatplane pilot must preflight the floatplane, must evaluate prevailing conditions, and must be familiar with float hydrodynamics and performance factors (para 29 and 30). To facilitate the preflight inspection afloat, waders or a few planks across the floats could be provided. Pilot preflight inspection procedures for the floatplanes are—

a. Visually inspect the floats,¹ fittings, water rudders, and (where applicable) the auxiliary vertical fins.

b. Carefully inspect the empennage for any physical damage (the empennage is bathed in spray during takeoff).

c. Check for excess water in the floats.

33. Prevailing Conditions

Prior to taxiing or flying the floatplane (sec III below), the floatplane pilot must evaluate the weather and the surface over which the takeoff will be attempted. The pilot must consider the—

a. Force and direction of the wind. He must keep in mind the fact that if a stiff breeze is blowing offshore, the floatplane will tend to weathercock into shoreline hazards or other water traffic. Also when

taxiing crosswind where maneuvering room is limited, the pilot should always guard against an unexpected gust which might turn the floatplane into upwind obstacles.

b. Location of storms or rough water that should be avoided.

c. Direction and force of water currents.

d. Size of the maneuvering area and the location of any obstacles.

e. Water depth.

f. Best direction of takeoff. This may be done, after taking into account all other factors, by allowing the floatplane to weathercock while in the displacement (floating) attitude.

34. Postflight Procedures

Floatplanes operating in salt water should be washed down with fresh water after each day's flying and the entire floatplane should be inspected for evidences of corrosion. In salt water operations, corrosion is a serious threat. Salt water spray and mist seeping into the interior of the floatplane result in corrosion of electrical wiring and other hidden hardware.

a. After a preliminary cleaning, prompt attention to oxidized spots (whitish scale on aluminum, rust on steel) will do much to prevent corrosion.

b. A thin coat of light oil should then be sprayed on the engine, propeller, and exposed fittings and control parts.

c. A rust-preventive compound should be applied as often as needed to fittings, strut ends, cables, bracing wires, and other steel parts exposed to submersion or spray.

d. Zinc chromate primer paint or paralketone adheres well to both aluminum and steel.

Section III. TAXIING AND SAILING

35. Taxiing

Before attempting to fly a floatplane, the pilot should become thoroughly familiar with its control on water since fundamental control characteristics differ in the floatplane and the landplane. On the ground, the landplane with engine idling remains stationary; on the water, the floatplane with engine idling (fig 8) is affected by a number of forces which cause it to move. Another difference is the weathercocking tendency of the floatplane. Therefore, successful completion of a few water landings under favorable conditions of water and weather may lead to unjustified confidence and to serious difficulty later.

a. *Water Rudders.* The air rudder is almost useless on a floatplane at slow taxiing speeds. Water rudders on floats are necessary for taxiing precision. They are coupled to the rudder pedals and raised or lowered

by a cable leading from the cockpit. Usually retracted prior to takeoff run (para 38c(2)), they remain retracted until the landing run is decelerated. They should normally be down when taxiing. Water rudders are most effective when the floatplane is moving slowly, since the turbulence or wake which occurs at higher speeds decreases their response to control movement.

(1) When the U-1A water rudders are raised, they are disconnected from the air rudder. When the water rudders are lowered, the rudder pedals may have to be fully deflected either way to engage the water rudder system. Engagement can be felt by the increased resistance to movement of the rudders.

(2) Difficulty in deflecting or raising water rudders indicates that a cable has jumped its pulley. The water rudder handle should be lowered slowly to avoid jumping pulleys.

b. *Elevator Position While Taxiing.* In taxiing the floatplane, the pilot should normally hold the control

¹Since floats are divided into watertight compartments, all handheld covers should be removed when checking for leaks or damage.

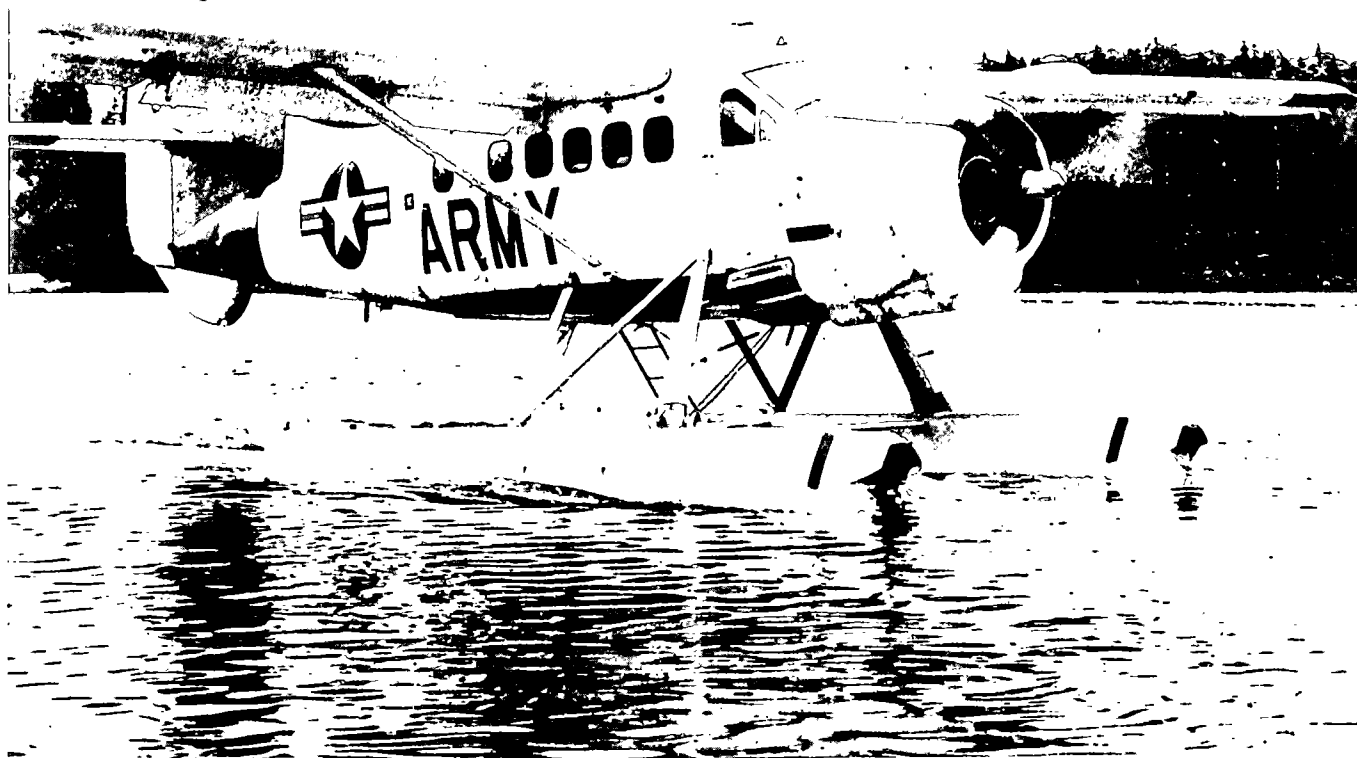


Figure 8. U-1A floatplane taxiing with engine idling.

stick (or wheel) all the way back (i.e., elevators full up). Thus the bows of the floats are lifted, reducing highly abrasive spray on the propeller. Normally the floats will tend to rise by the bow to a certain height and then flatten out. As soon as the pilot sees that the bows are not rising any farther, he should let the stick ride forward to a more or less neutral position. Then the floats will begin to plane and run along in a more nearly level position on the step. The pilot may have to push the stick forward somewhat ahead of neutral to get the plane on the step, but this is generally unnecessary.

c. Most Efficient Planing Angle. Once the floatplane is definitely on the step, the most efficient planing angle of the floats from the standpoint of resistance is that at which the tail of the floats almost, but not quite, touches the water. Running the floatplane at a flatter angle (nose too low) tends to wet more of the forward bottom of the floats, increasing resistance and diminishing speed. This effect can generally be felt by increased drag and a slight nosing over tendency. Conversely, running the floats at too large an angle (nose too high) drags the tail of the floats in the water, and will noticeably increase resistance.

When an attempt is made to drag a floatplane off the water with the stick well back, the floatplane "feels" all right. In attempting to take off if it fails to break loose, there is an almost irresistible tendency to pull the stick back still further in the vain effort to get into the air. However, not many floatplanes can possibly respond to this procedure, and the correct procedure is to let the nose fall again to the proper angle and *keep it there* until flying speed has been reached.

d. Taxiing Speeds. The speed of water-taxiing a floatplane is usually very slow, occasionally very fast, but never intermediate except for short periods under difficult wind conditions. Intermediate speeds plow up excess water and put an undue strain on engines. Slow speeds part the water with a minimum of power and prevent engine overheating. When taxiing on the step (planing), the floats plane (ride) high—almost out of the water; and the airflow provides adequate cooling for the engine cylinders.

36. Porpoising

The oscillating about its lateral axis or the rocking up and down of the floatplane is called *porpoising*. Some floatplanes have a moderate tendency to rock

or porpoise. Porpoising generally occurs at about the time, or immediately after, the plane goes on the step. It is also likely to occur if the plane is taxiing on the step downwind and may occur when falling off the step after a landing. Any violent porpoising that occurs with power on is dangerous, as it will become increasingly violent. Immediate corrective action should be initiated. Porpoising is always checked by closing the throttle and holding the stick full back. No attempt should be made to eliminate a porpoise by use of control column with power on.

37. Getting on the Step

Some floatplanes are difficult to get on the step; a little rocking will sometimes help. Sometimes the use of flap will assist in getting on the step. However, rocking should not be tried until the bow has definitely come full up, to the point where the ship is about to go on the step, since any forward stick before this point is reached will only push the float bows back into the water. Rocking is accomplished by moving the stick rhythmically forward and back (with emphasis on the forward motion), so as to gently "nudge" the ship up on the step, but it is important not to let the rocking become too exaggerated. If any

uncontrollable rocking develops, it can generally be checked by cutting the throttle and pulling all the way back on the stick. This will tend to check the rocking by forcing the tail of the floats into the water.

38. Floatplane Attitudes While Taxiing

The three taxiing attitudes or positions of the floatplane are *floating* (engine idling), *noseup*, and *planing* (running on the step). Each can be used during specific conditions of wind, water, and available maneuvering room.

a. *Floating*. In the floating attitude (fig 9), the floatplane is on the water with the floats partially submerged, much as when at rest. Unless opposed by wind or tide, the plane moves slowly forward, even with closed throttle. More lateral area of the floatplane is behind the center of buoyancy than in front. Consequently, any crosswind tends to weathercock the nose of the floatplane about the vertical axis passing near the center of buoyancy and into the wind. At engine-idling speed during calm weather conditions, the floatplane may be steered in short turns somewhat in the manner of a powerboat. The stick is held full back in the floating attitude. Although the

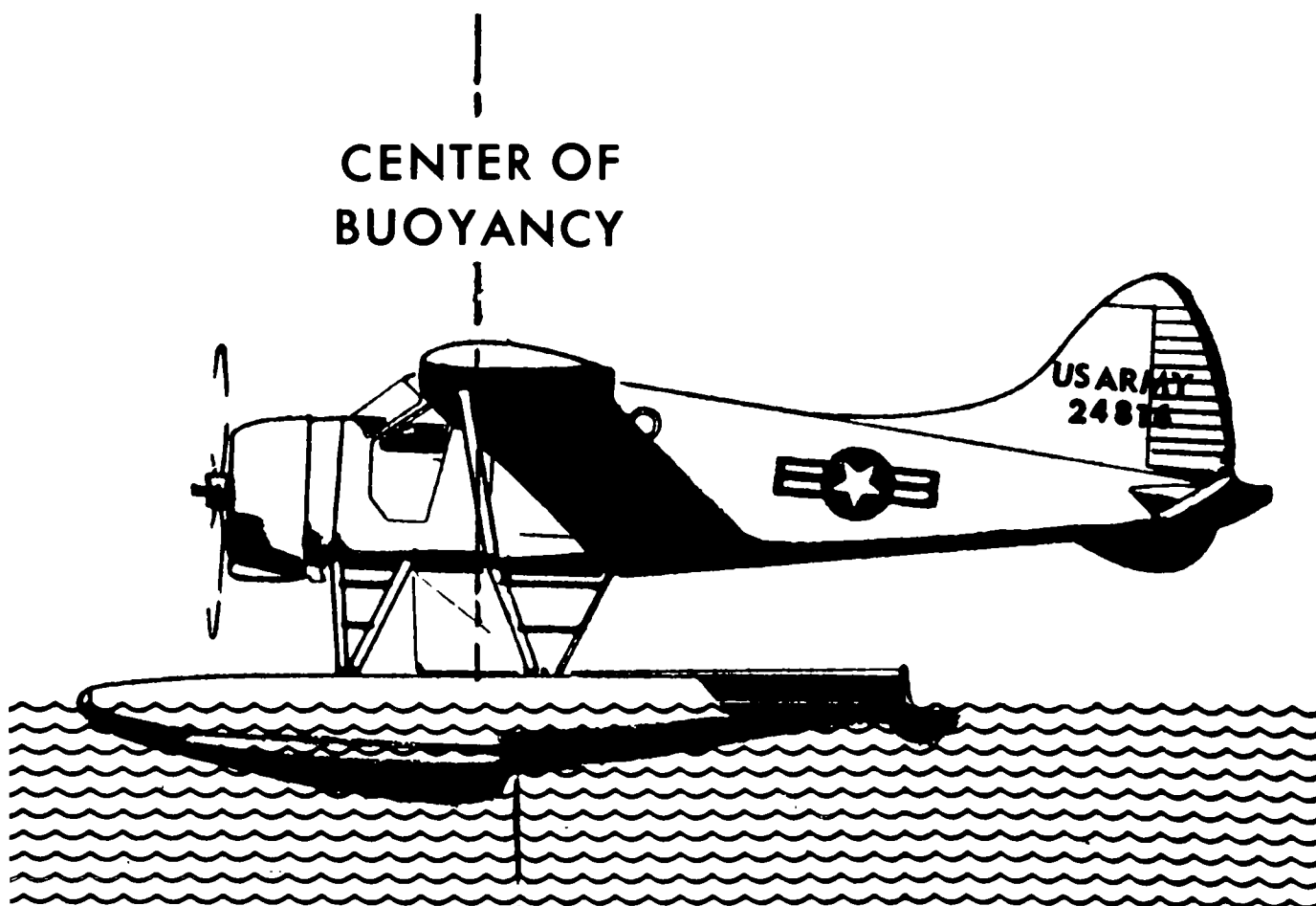


Figure 9. The floating attitude.

spray from the water is now greatest, the propeller will not pick up spray even when waves are breaking over the floats. However, halfway between the floating attitude and the noseup attitude, the increased speed picks up spray that the propeller cannot clear. To minimize this spray as much as possible, the transition from the floating attitude to the noseup attitude is passed through as quickly as possible.

b. Noseup. The noseup attitude (fig 10) is achieved by adding considerable throttle with the stick held full back. As speed increases, the force of the water on the forward bottoms will cause the bows of the floats to rise until about one-third of their length is clear of the water. Holding the stick full back speeds taxiing through the critical point at which the propeller is picking up spray and assures the desirable maximum bow elevation. Maximum power should be used through the point of spray-casting and then reduced to a predetermined amount for the rest of the run. In the noseup attitude, considerable spray arises well aft of the propeller. This spray is an indication of the heavy work being performed by the engine, and the pilot must monitor temperature gage

indications closely. The floatplane is now supported by the aft two-thirds of the floats, and the center of buoyancy has traveled well aft (compare figures 9 and 10). In the noseup attitude, more lateral area of the floatplane is in front of the center of buoyancy than behind it. Consequently, when taxiing noseup in a crosswind, many floatplanes will tend to turn downwind by weathercocking about the vertical axis passing near the center of buoyancy. This tendency will increase as additional power is applied. Normal (light wind) rudder control is reasonably positive. Propeller air wash assists in air rudder control; this is beneficial because the water rudders are operating in a disturbed wake and are therefore less effective than at idling speeds. The turning radius in the noseup attitude is much larger and allowance for maneuvering room must be generous.

c. Planing. Spray is at a minimum in the planing attitude (fig 11) and the engine is adequately cooled. As speed increases, the floatplane comes more out of the water and water drag on the floats decreases. However over long distances, planing in a STOL floatplane should be avoided. This requires more

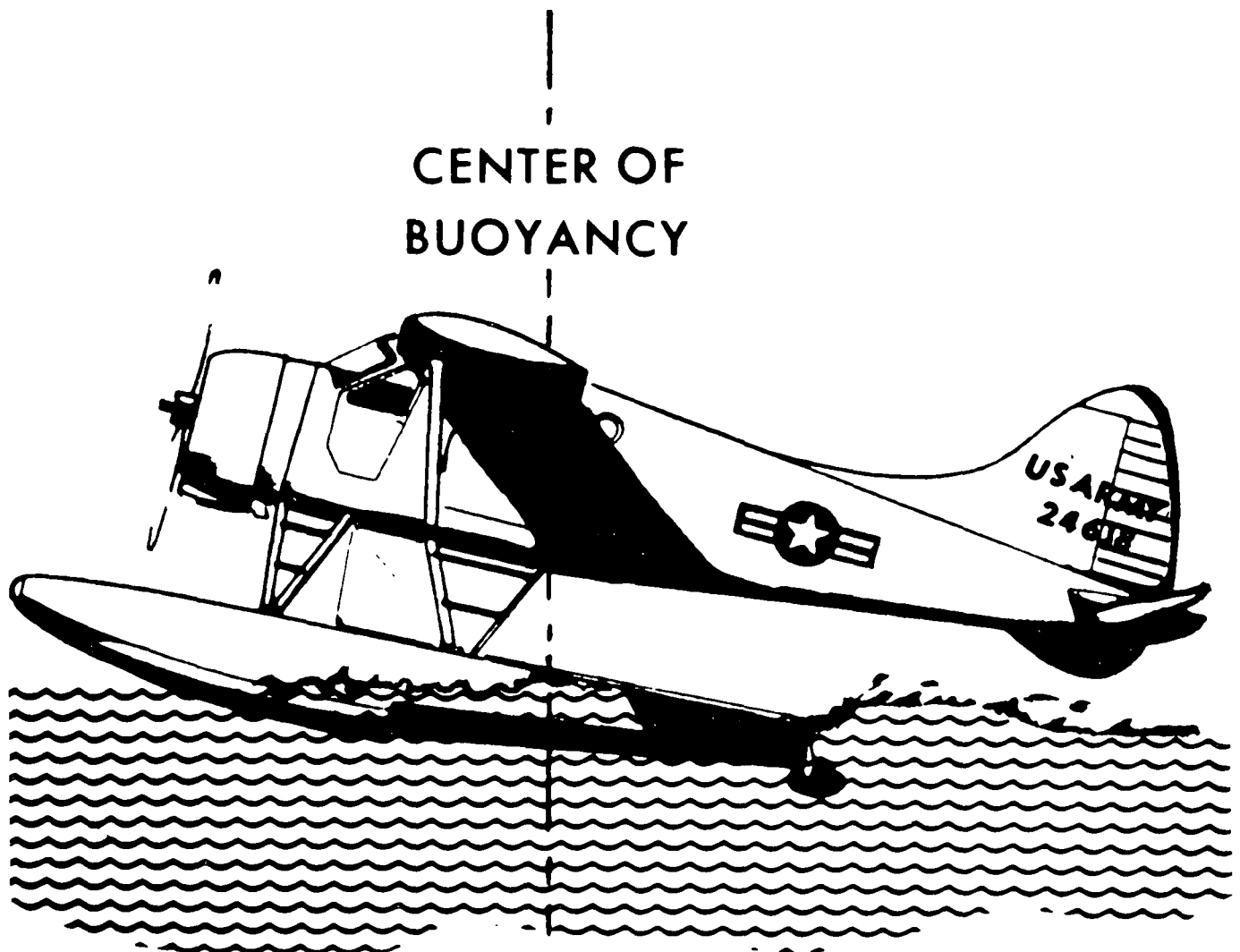


Figure 10. The noseup attitude.

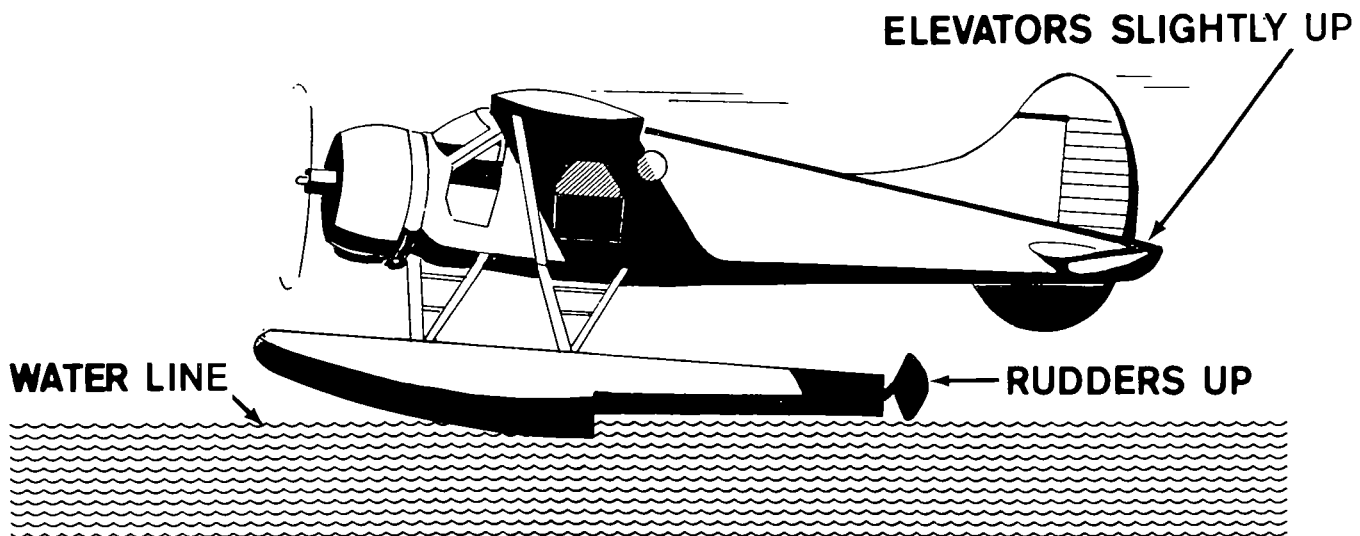


Figure 11. The planing attitude.

power, places a greater strain on the floatplane, and increases the danger of hitting objects hidden in the water. Flying provides better control than on-the-step taxiing. For STOL floatplanes, the pilot should just lift the floatplane clear of the water, fly at minimum speed and power to the desired point, and then land. Planing should never be attempted in rough water, during conditions of poor visibility, or in an area containing submerged stumps, floating debris, or other hazards.

(1) Planing is initiated by holding the stick hard back and opening the throttle to full takeoff power. The stick remains fully back until the bows of the floats cease to rise. At this point a release of back pressure will allow the floats to climb up on the step and plane on the surface of the water. A very slight back pressure on the stick is required to minimize the water drag fore and aft of the step.

(2) As soon as planing is achieved, acceleration is increased; therefore, power must be reduced to avoid takeoff. Prior to opening the throttle to full takeoff power, water rudders are usually retracted to prevent undesirable water drag and excessive flutter of the rudders in the churning water. Water rudders are sometimes left down in the early stages of crosswind takeoffs. In moderate to strong crosswind takeoffs, the water rudders may be needed in the early stages of the takeoff for directional control. The water rudders are then retracted after takeoff.

(3) The air rudder provides adequate control for the smallest radius of turn that can be safely made in the planing attitude. On-the-step turns (para 39c) require a large radius of turn, for while planing the floatplane is supported *on* rather than *in* the water. For this reason, a higher rate of speed is necessary.

39. Turns While Taxiing

Whenever possible, the pilot should plan for an approximate upwind taxiing course. Turning on water at low speed in light wind and calm water is mainly a matter of applying rudder. However, as wind velocity increases, hazards become more pronounced; and a point is reached at which it becomes inadvisable to attempt any turn and sailing must be initiated (para 40).

a. Upwind Turns. To turn into the wind, the throttle should be closed and the floatplane allowed to weathercock. The weathercocking tendency of the floatplane will turn it on a shorter radius more safely than any other way. If the wind is so strong that the rate of turn is excessive, the pilot applies opposite rudder and up aileron into the wind, thus slowing the rate of turn. In an upwind turn with crosswind from the left, right rudder may be needed to counteract engine torque and weathercocking (fig 12). When turning into the wind, throttle should not be applied since this would increase centrifugal force during the turn. Centrifugal force, combined with the force of the wind on the upwind side of the floatplane (fig 13), would force the downwind float deeper into the water and expose the undersurface of the upwind wing. Thus, the downwind wingtip might be pushed into the water, causing the floatplane to capsize.

b. Turns to the Downwind. Wind and water conditions may be such that a turn to the downwind will cause the floatplane to capsize. The safest procedure may be to sail (para 40) or to take off, go around, and land at some point downwind from the docking or mooring position. When possible, the turn to the downwind should be made to the left to allow engine torque to assist in making the turn. The turn to the downwind should be aborted any time that its outcome is questionable.

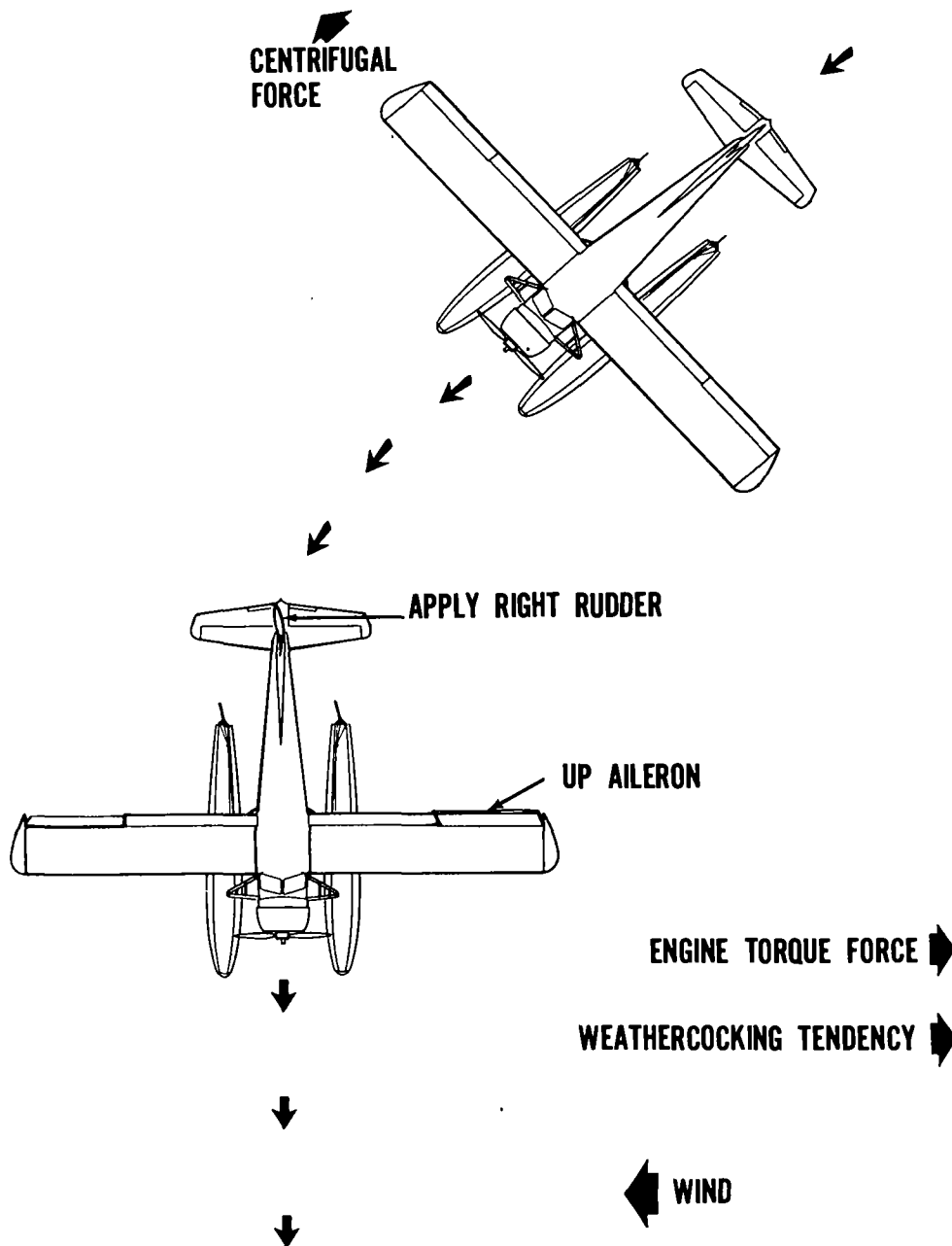


Figure 12. Applying right rudder in upwind turn with crosswind from left.

(1) If the wind is strong enough, a point can be reached where the water rudders can no longer counteract the weathercocking tendency of the floatplane at idling speeds. It may be possible, however, to turn to the downwind by using the momentum imparted by the weathercocking action. With the engine idling, the nose is swung in one direction as far as the wind will allow it to go. Full opposite rudder is now applied. As the floatplane passes directly into the wind, moderate power is applied smoothly (fig 14) to give more air rudder control and also to raise the nose. This provides weathercocking downwind (para 38b) and weathercocking forces assist in initiating an accelerated swing

which may continue until a full downwind heading is reached.

(a) Turns to the downwind usually require additional throttle to establish the noseup attitude. This attitude assists in overcoming the upwind weathercocking tendency because the center of buoyancy is moved rearward and the weathercocking action then tends to point the floatplane downwind. This turning procedure may permit maneuvering in winds of considerable force.

(b) The speed of the turn determines the amount of centrifugal force in opposition to the force of the wind (fig 15).

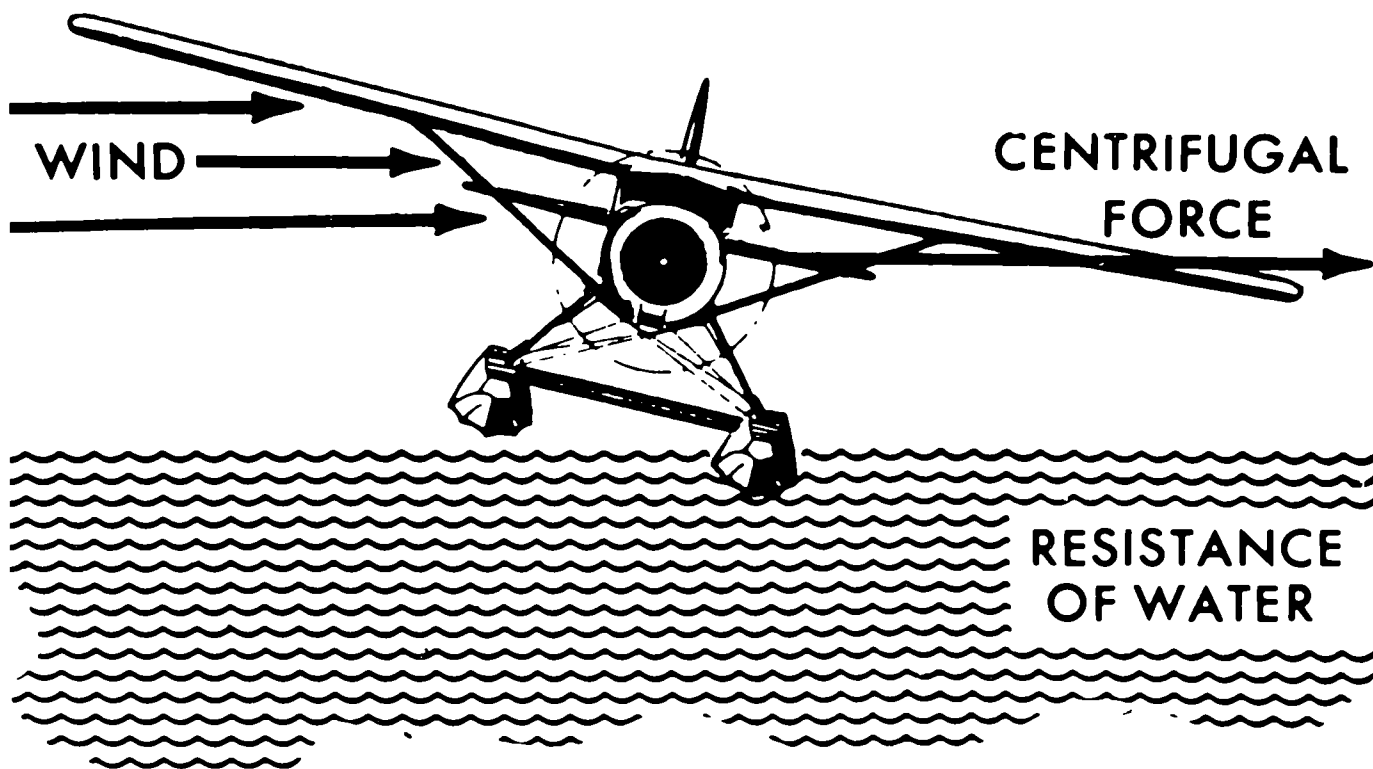


Figure 13. Capsizing action of wind.

(c) Should the downwind float begin to bury in the water during the turn to the downwind, the throttle should be closed immediately and the plane allowed to resume an upwind heading.

Caution: When the throttle is closed, downwind rudder should be applied to slow the turn and to minimize centrifugal force, which is now acting in the same direction as the wind.

(2) If the water is not too rough, a downwind turn may be possible during a lull between wind gusts. The greatest danger is while crosswind. The upwind float may lift on a wave crest and the other fall into a trough. Under this condition, the whole undersurface of the upwind wing is exposed to the force of the wind, while the downwind wing is too close to the water for safety.

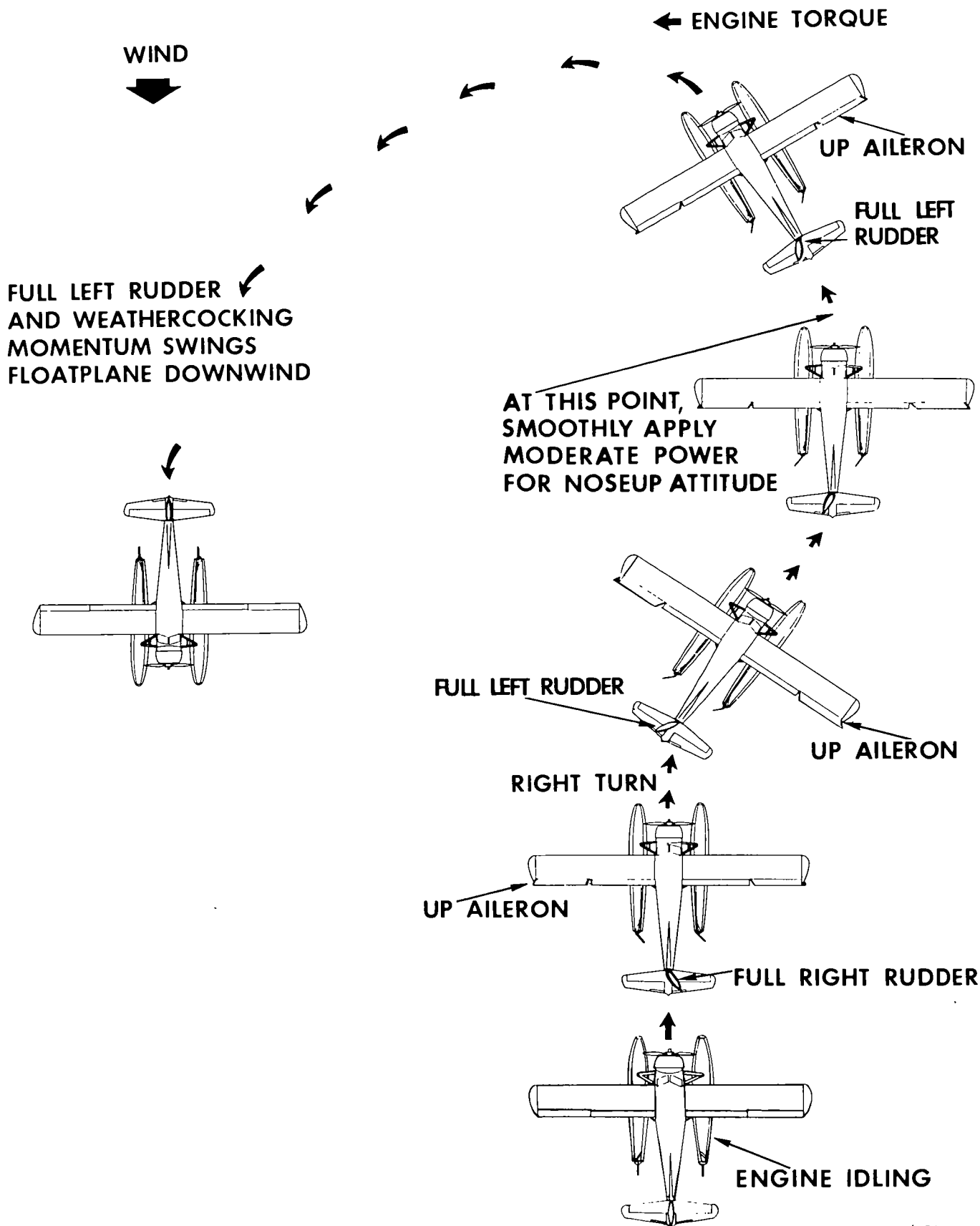
c. On-the-Step Turns. Water rudders are retracted as the float-plane attains the planing attitude. An inexperienced pilot should only attempt on-the-step turns in a light wind.

(1) *Downwind.* When taxiing downwind on the step, the pilot should decrease throttle before making a turn. This allows the floatplane to return to the displacement position and weathercock into the wind without any capsizing tendency.

(2) *Upwind.* Upwind on-the-step turns should be wide, with gradual changes of direction. There

should be enough area to complete the turn without stopping, as the capsizing tendency is strongest in the crosswind position at planing speeds. Rudder movement brings into play the righting effect of centrifugal force. For example, if the right wing of the floatplane begins to dip (fig. 13), prompt application of right rudder results in centrifugal force opposing the upsetting force of the wind. Ailerons on Army floatplanes are effective to some extent at low taxiing speeds and this effect increases with airspeed.

d. Modified On-the-Step Turns. A modified on-the-step turn is frequently used at slower speeds and in takeoff runs from confined water areas (para 47). Speed is adjusted between noseup and planing and the floatplane attains a semiplaning attitude. Using this technique, the skilled floatplane pilot can make turns out of the wind under rougher conditions than the noseup turn allows. This maneuver requires precise rudder control of centrifugal force to maintain lateral balance against the force of the wind. Once the turn is started, the pilot should concentrate on maintaining lateral balance until the downwind heading has been achieved. Throughout the turn, just enough power should be used to keep the floats bow high and well clear of spray in a semiplaning attitude. If the speed were allowed to increase to a point where the floatplane reached a full planing attitude, the bow of the floats would drop, with a resulting loss in seaworthiness, an increase in weathercocking action, and a tendency to porpoise.



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Figure 14. Turn to the downwind (special technique).

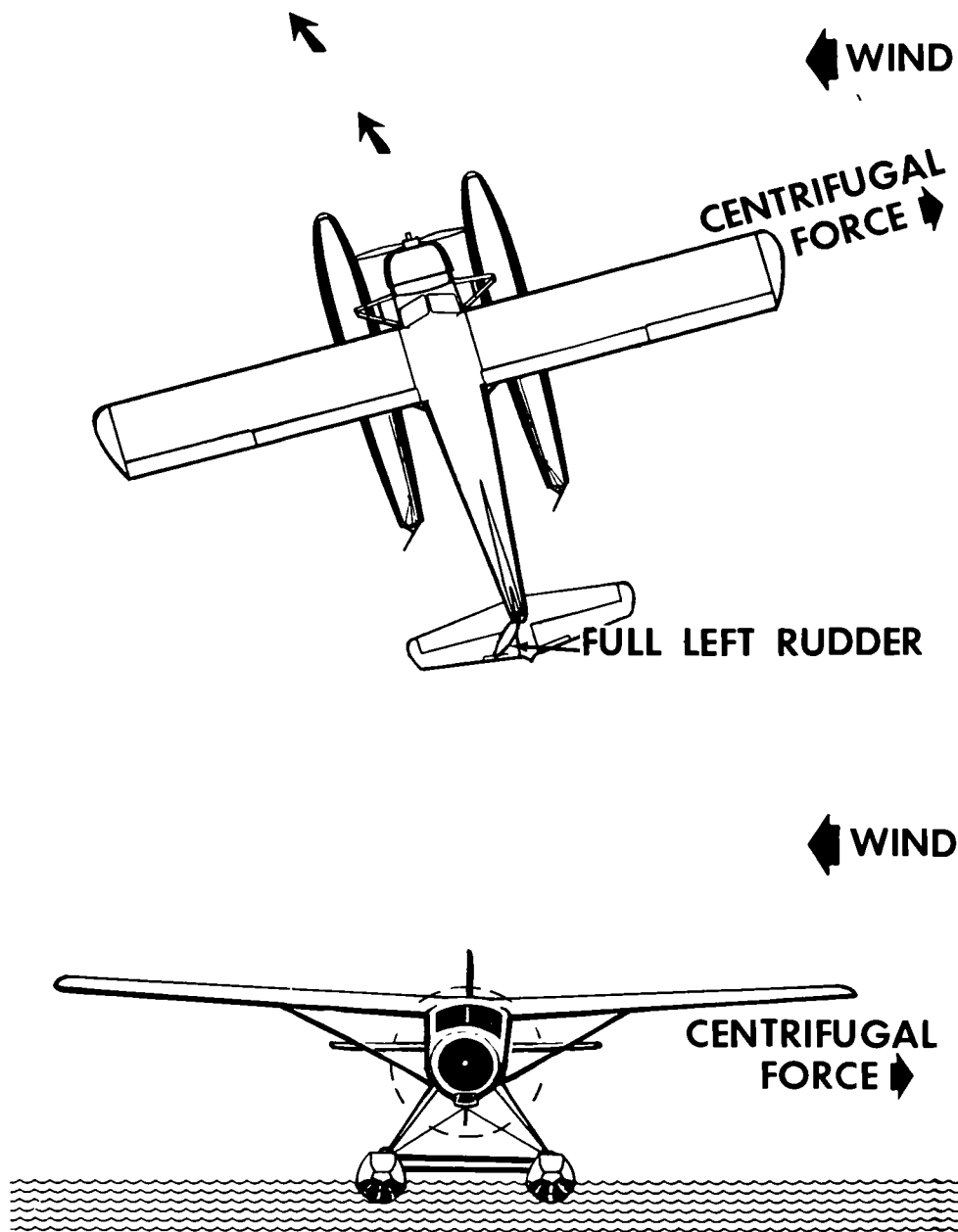


Figure 15. In a turn to the downwind, centrifugal force opposes wind force.

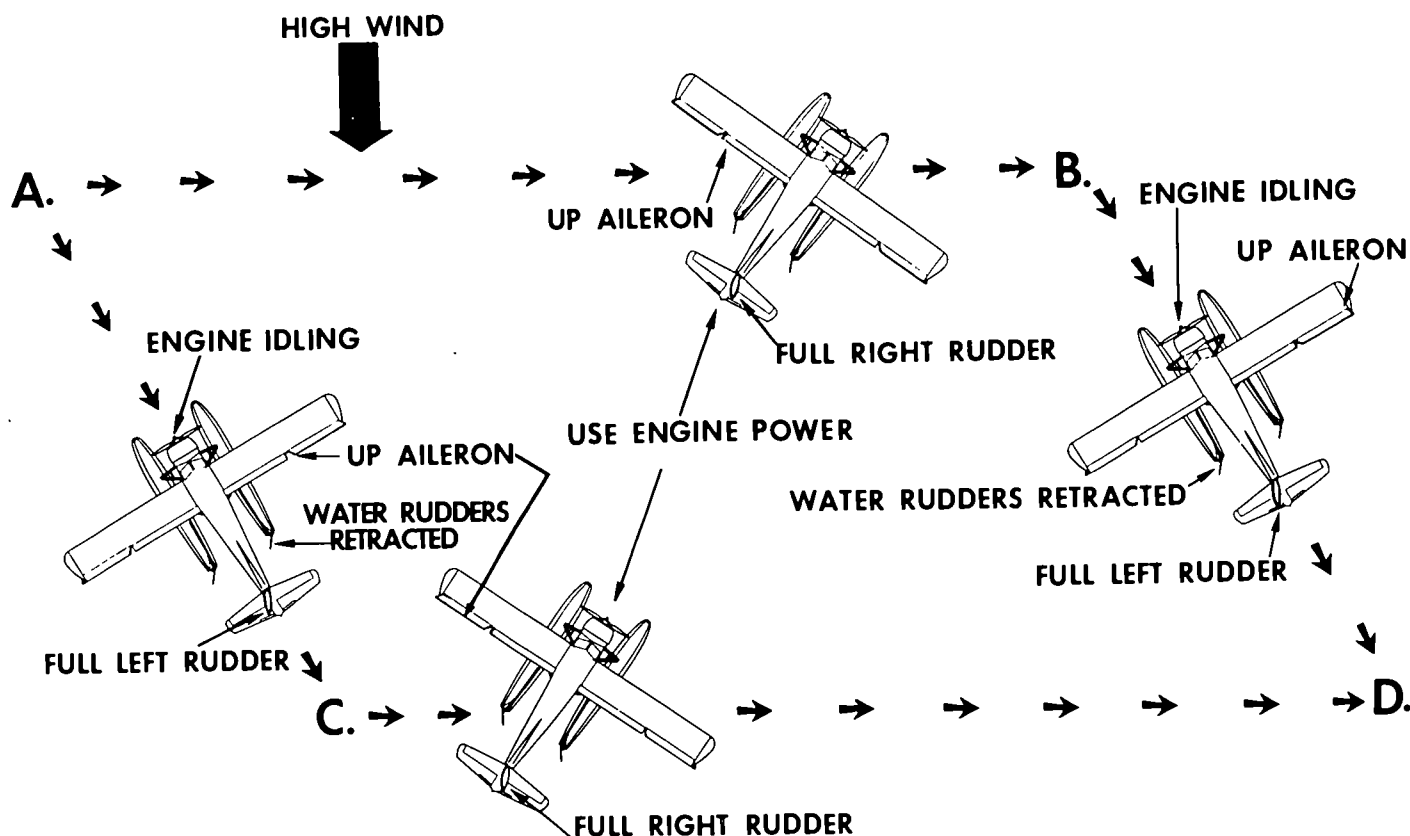
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40. Floatplane Sailing

Sailing is a water surface operation in which the wind is employed as a major motive force, with engine power used as necessary. Floatplane sailing techniques are most frequently employed in reaching a crosswind or downwind objective when the weather is too rough to permit safe downwind turns or crosswind taxiing. The relative amount of backward drift will usually determine whether crosswind or downwind sailing or a combination of both should be used. When backward drift is fast, the wind effect on the floatplane is negligible (except in producing drift), and the floatplane travels through the water in the direction in which the tail is pointed (A-C and B-D, fig 16) because of the keel effect of the floats.

However, when there is little or no backward drift or motion through the water as a result of propeller thrust, the keel effect of the floats is negligible, and the force of the wind on the fuselage moves the floatplane more or less sideways through the water in the direction in which the nose is pointed (A-B and C-D, fig 16).

a. Downwind Sailing. Downwind sailing (A-C and B-D, fig 16) is usually employed during rough weather to reach a downwind objective; for example, a base on the lee shore of a lake. With the rudder and ailerons in neutral, the direction of travel is straight downwind, tail first. Deviations from the natural downwind path up to 30° may be accomplished by skillful use of the controls. If the wind is



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Figure 16. Two possible courses in sailing from A to D.

moderate, the plane will move in the direction in which the tail is pointed, due to the keel effect of the floats. Stronger winds overcome this keel affect, with resultant movement toward the lee side. Water rudders should always be retracted when sailing backward. (Their effect would oppose the action of the air rudder.) Aileron application assists the air rudder. Lowered flaps and open cabin doors accelerate progress. Cutting the engine expedites downwind sailing by removing unwanted propeller thrust. This expedient is usually inadvisable when in proximity to rocky shores, unless the engine can be relied on for a prompt restart or an emergency anchor is available for instant use. Another expedient for reducing propeller thrust is to operate on one magneto or to turn the magneto switch alternately on and off. Although the reversible pitch propeller is the best answer to this problem. Army floatplanes are not currently equipped with this propeller.

b. Crosswind Sailing. Crosswind sailing (A-B and C-D, fig 16) permits progress in a direction across the wind in rough weather. The throttle should be opened just enough to offset the push of the wind

with rudder and aileron applied to point the floatplane nose toward the side on which the objective lies. With this setting, the floatplane will crab slowly and safely across the wind. Engine speed should be slow enough to avoid excess spray against the propeller. Strong gusts of wind may momentarily shove the floatplane a few degree off heading, but the plane will resume its previous heading when the gust has passed.

c. Effect of Tide or Current. Since sailing is a slow process, exposure to tides or currents for prolonged periods can be anticipated. A tide or current which moves with the wind is advantageous. It assists in overcoming excess propeller thrust and makes closing of the throttle to reach a downwind objective unnecessary. A tide or current against the wind is unfavorable; it produces rougher water and hinders backward and lateral progress. However, winds strong enough to prevent free maneuvering (normal taxiing) are usually adequate to overcome tide or current. Tides and currents present the greatest problem and must be accurately analyzed when the floatplane is to be maneuvered in tight places in moderate winds.

CHAPTER 6

FLOATPLANE AND AMPHIBIOUS FLOATPLANE TAKEOFFS

Section I. FLOATPLANE TAKEOFFS AND CROSS-COUNTRY FLYING WITH FLOATS

41. Normal Takeoff

With a lightly loaded floatplane, takeoff into a moderate breeze is best. The floatplane is brought up on the step as described in paragraph 38c(1). As speed increases, the slight back pressure on the stick maintains the planing attitude and then allows the floatplane to fly off the water. Premature attempts to pull the floatplane off will merely drag the heels of the floats, slow it down, and require a longer run to recover lost speed.

a. *Takeoff Trim.* The best procedure for learning efficient floatplane takeoffs is to release all stick pressure as soon as the throttle is fully open and the float bows have begun to ride high. The floatplane will climb up on the step and accelerate more cleanly if no attempt is made to force it. A slight touch of back pressure on the stick may be necessary at the last moment to break loose from the water, depending on water condition and elevator trim. A few practice takeoffs will familiarize the pilot with the optimum takeoff angle, which is about midway between the noseup attitude and dragging the heels of the floats in the planing attitude. Also, this procedure permits experienced floatplane pilots to become familiar with different types of floatplanes. There are slight variations in the optimum takeoff angle—the float heels are low (just clear of the water) with the entire floats running out of the water except for a small section at the step.

b. *Use of Flaps and Elevator Trim Tab.*

(1) *Flaps.* On U-1A and U-6A floatplane takeoffs, the pilot uses TAKEOFF flaps at all times. Flaps may be reduced in some abnormal conditions, but are never less than CLIMB flaps. Attempting to pump flaps down during takeoff is not recommended.

(a) *Limited takeoff space.* The pilot should not allow himself to become so absorbed with cockpit procedures during takeoff that he forgets there must be enough space for climbout after flying off the water or to abort takeoff at the end of the run.

Caution: Before starting the takeoff run, the pilot should always pick out a point to terminate the takeoff. He must close the throttle when that point is reached.

(b) *Rough water.* After lift-off planing speed is reached, flaps may be used effectively to fly off rough water. This use of flaps may prevent prolonging the rough buffeting action of the waves on the floats.

(2) *Elevator trim tab.* On U-6A floatplane takeoffs, the pilot may find it advantageous to preset the elevator trim tab to provide neutral stick pressures during planing. This enables him to feel water resistance and properly sense accelerations. On the U-1A, the wing flaps are mechanically connected to the trim tab on the left elevator so that actuation of the wing flaps automatically deflects the trim tab to maintain the longitudinal trim.

42. Downwind Takeoff

Downwind takeoffs should be avoided except in light winds and comparatively smooth water. The nose should be held slightly higher than usual. If necessary to abort the takeoff, the throttle is closed to let the water produce rapid deceleration.

43. Crosswind Takeoff

Crosswind floatplane takeoffs are frequently necessary. They can be treated like landplane crosswind takeoffs only if the wind is very light. In stronger winds, the downwind float will tend to bury as the nose rises while getting on the step. If this happens, the pilot cuts the throttle immediately and allows the floatplane to weathercock. Another method is to start the run into the wind and make a step turn to the desired heading. This opposes centrifugal force to the wind and permits safe takeoff in maximum flyable crosswinds.

44. Glassy Water Takeoff With Heavy Load

On U-1A or U-6A glassy water takeoff with heavy load, the technique is to allow the floatplane to come onto the step by itself. *The pilot does not force the floatplane up on the step*, as this only increases drag and slows down the acceleration. Once on the step, he watches the airspeed build up and does not try to lift the floatplane off until 55 miles per hour is registered on the airspeed indicator. If trimmed correctly and the center of gravity is within limits, the

floatplane will fly itself off just as it does under normal water conditions. Since glassy water takeoff with heavy load takes longer for the speed to build up, the airspeed indicator is the key to ease of takeoff. On all floatplanes, excessive rocking (longitudinally or laterally) is detrimental and should never be used.

a. Breaking Loose From the Water. One method to assist a glassy water takeoff is to make three 360° turns. The disturbed water usually remains long enough to be of assistance in breaking loose from the water.

b. Other Considerations. Occasionally, swells will be present in glassy water. Since a cross-swallow run will result in porpoising, the takeoff run should be made parallel to the crests and troughs. If all efforts to take off in calm water fail, the pilot checks that all water has been removed from the floats, reduces the load, or ties up and waits for the weather to change. Repeated unsuccessful runs usually result in burned or warped valves and possible engine failure. This is an important consideration when operating in remote areas.

45. Rough Water Takeoff

Rough water is accompanied by winds above 18 knots. These winds are usually strong enough to shorten the takeoff run. Waves caused by surface winds run across the wind, as contrasted with swells or the churned-up condition caused by river currents bucking tide. Rough water conceals stumps, rocks, floating logs, and other hazards. When a taxiing reconnaissance is not feasible, the takeoff path should be viewed as carefully as possible before the run is initiated. Although the pilot can do much to ease the punishment the floatplane absorbs in rough water, the best advice is: *When in doubt, don't try it.*

a. In beginning the rough water run, the throttle should be opened just as the bows begin to rise on a wave. This avoids digging in the bows and reduces spray on the propeller.

b. After the transition to planing occurs, the nose should be held slightly high to keep the bows from crashing headon into the waves.

c. If the waves are large, each bounce will push the nose up. Forward stick should be applied promptly to avoid crashing into the next wave in a stall, then just before the succeeding wave is reached, back stick should be applied to avoid a nose-on collision. Close timing is required.

d. Taking off is often a succession of bounces from wave crest to wave crest until flying speed is attained. However, rough water can break the forward struts as it bounces the floatplane into the air. With broken struts, the floatplane is not considered airworthy. Also, landing and docking become critical since the nose drops to a point where the propeller digs water and may slash the bows of the floats.

e. The final bounce lifts the floatplane, hanging in the air, with minimum flying speed. Good control touch is required to prevent settling back into the waves.

46. Swells, Tides, and Currents

Swells, tides, and currents follow no firm rules relative to wind direction. Swells require a takeoff run parallel to the crests. The motion of the swells makes it very difficult to keep the floatplane centered on a crest, and the major part of the takeoff run is usually accomplished with first one wing low and then the other. Under these conditions, even a light crosswind makes a takeoff inadvisable. Tides and currents, in the absence of wind, expedite the takeoff run, much as a downhill slope aids the landplane pilot.

a. If wind and water are moving in the same direction, an upwind takeoff is normally best. The takeoff will be slightly retarded by the action of the water.

b. A tide or current opposing the wind causes rougher water than the wind alone will produce. For example, a 20-knot wind moving against a 10-knot current produces water roughness equivalent to a 30-knot wind. However, the wind available for assisting the takeoff is 20 knots, not 30.

c. When two movements of water (river and sea) oppose each other, sometimes the only safe solution is to find a patch of relatively smooth water for takeoff. This search may require a mile or two of taxiing, but is preferable to breaking the struts, damaging the floats, or sinking the floatplane.

47. Takeoffs in Limited Areas

Confined areas such as small lakes with forested shores are easier to enter than leave. Bush pilots recognized this years ago and devised the circular takeoff for use in light wind conditions.

a. One procedure which may be used in light wind conditions is to get on the step in any convenient direction and head for the downwind end of the body of water. A step turn is made into the wind, with the floatplane almost ready to take off as the turn is completed. This procedure is somewhat hazardous, and requires expert execution to avoid an upset. In making the step turn, the throttle may be regulated so that the floats are dragging a little more water than when planing cleanly. This expedient reduces the centrifugal force without much loss of space. Full throttle may be added just before completing the turn.

b. For calm conditions, the pilot may make use of the floatplane wake to assist in breaking loose from the water. This procedure is somewhat hazardous and requires expert execution.

48. Takeoff Cautions

A float puncture can occur unnoticed and can produce a slight unnatural trim when sitting in the water, a longer-than-normal takeoff run, extreme wing heaviness at low flying speed, and poor-to-nil climb performance. Minor repairs may be carried out at the operation site with the aid of the emergency repair kit.

a. Ships and large boats leave heavy swells which should be avoided by floatplanes. Small powerboats should be given a wide berth, since their skippers may not be aware of the limited maneuverability of floatplanes.

b. Takeoffs in freezing temperatures will coat the tail with frozen spray, and thus effectively block the controls. The controls should be kept moving for a minute or two after takeoff. If the water rudders are likely to be needed for landing (crosswind or downwind), they should be left down, as they otherwise will freeze in the retracted position.

49. U-1A and U-6A Floatplane Takeoff

When operating from large areas of water, the pilot taxis into the takeoff position, retracts the water rudders, and waits until the floatplane weathercocks into the wind before taking off. If operating from narrow lakes or rivers under crosswind conditions, it is advisable to keep the water rudders extended during takeoff. The rudders are retracted after the floatplane is airborne.

a. *U-1A Floatplane.* Having completed the engine runup and before takeoff checks, the pilot lines up the floatplane into the wind with the maximum length of takeoff run ahead. Then holding the control wheel aft of neutral, he advances the throttle smoothly to take off power. As airspeed increases, the nose of the floatplane will rise. When it stops rising, the pilot allows the control wheel to move toward the neutral position. The nose will start to drop as the floatplane rises onto the step of the floats. The pilot applies a slight aft pressure on the control wheel just before the floatplane reaches level flight attitude so that it will fly off the water at a safe airspeed.

Note. Any tendency of the floatplane to porpoise on takeoff is an indication that the floatplane is loaded an appreciable amount aft of the rear center of gravity limit.

b. *U-6A Floatplane.* The pilot advances the throttle smoothly to takeoff power, holding the control wheel aft of the neutral position. The floatplane should immediately rise onto the step, with no tendency to porpoise, even in rough water. The pilot allows the floatplane to become airborne at approximately 60 knots (69 mph).

50. Cross-Country Flying With Floats

In many locations, it is often possible to keep within gliding distance of some body of water by flying at

an appropriate altitude. For example, the U-6A floatplane will glide approximately $3\frac{1}{4}$ statute miles in still air for every 2,000 feet of altitude. However, it is not always possible to determine the nature of the water from high altitude (i.e., rocks, logs, or other obstructions may make a safe landing difficult or impossible). Even landing on a level field might be preferable to a body of water that is too small or one that has too many obstructions. Cross-country flying in floatplanes differs from landplane operation mainly in that support facilities for floatplanes are scarce and sometimes nonexistent. The route to be flown will usually be dictated by refueling considerations. The pilot is often on his own for overnight stops, emergency refueling, maintenance, and minor repairs; consequently, his equipment (c below) must be adequate.

a. *Landing in Strange Waters.* Landing in strange waters requires a thorough reconnaissance, especially for tides or currents, rocks and shoals, and usable docking or mooring facilities. In confined waters, the pilot should determine that adequate space is available for the takeoff. To determine that the water is deep enough to safely land the floatplane, certain signs are helpful. In lakes, a brown hue indicates shallow water and a black hue indicates deep water. Water plants seldom grow in deep water. In small rivers, the stronger currents and deeper water are usually found on the side of the higher banks. Characteristic ripples produced by sandbars and rocks usually signify shallow water. Local boat traffic is a reliable indicator for selecting a good landing area, although shipping traffic may limit availability. Rivers and inland (fresh water) lakes and reservoirs may look inviting, but many are closed to floatplane operations by State laws.

b. *Crossing Dry Land.* Routes over land areas can be accomplished with confidence. Since the takeoff after a "dry" landing in a floatplane is always complicated, the weather and the condition of the engine should be considered in planning the route; one or the other may dictate a longer route to stay near water. In dry areas, such as the Southwest, map information should be verified. Rivers often become a thin trickle, while new reservoirs, not shown on an old map, may provide excellent ports.

c. *Equipment.* Maximum allowable gross weight permitting, the floatplane pilot should carry enough equipment to make him self-supporting on intermediate or emergency stops. Much of this equipment may be stowed in the float compartments, especially the long lines that are infrequently used. If kept in the floats, hardware must be well padded. The following optional items can be useful in an emergency:

(1) Nylon lines, three-eighths of an inch in diameter—

(a) Two 100-foot lines for anchoring, mooring to pilings or trees, or casting to helpers on shore.

(b) Two 20-foot and two 50-foot lines for tying up to docks, tying down on shore, or for mooring bridles.

(2) Two fenders.

(3) One inflatable life vest for each person on board.

(4) Toolbox.

(5) Markers (plastic bottles).

(6) A bilge pump, large sponge, bailing can, or siphon hose for bailing out floats. The siphon is usable only on shore but is also useful for emergency refueling from cans.

(7) A paddle for paddling, poling, or fending off. A blunt hook on the handle is useful in hooking mooring rings. The paddle may be carried on the inboard side of a float by means of a bladetip socket and a stud passing through a hole in the handle and secured by an aircraft-type safety pin through the stud.

(8) A folding anchor for temporary mooring or for anchoring offshore in emergencies.

(9) An emergency repair kit including spare plugs, materials for patching floats, etc.

(10) One or more 5-gallon fuel cans: if full, as a reserve for emergency refueling on the water; if empty, as a container for transferring fuel from shore sources inaccessible to the floatplane.

(11) Funnel (with chamois skin).

(12) A few quart cans of engine oil.

(13) Hydraulic fluid.

(14) An inflatable rubber boat and a survival kit, especially for cold weather and remote areas. In a warm climate, a pair of sneakers may be advisable for foot protection in wading on rocky or coral bottoms. In a cold climate, hip boots may be useful.

d. Carrying Bulky Equipment. Especially in remote areas, it may be desirable to haul large objects such as spare struts, propellers, or even canoes, lashed to the floats or spreader bars. Care should be taken with airplane weight and balance; also, the strength

and security of lashings should be adequate to withstand air buffeting by the propeller blast.

e. Mooring and Securing. When traveling cross-country in a floatplane, it often is necessary to spend the night where there is no established seaplane base. This means that the plane must either be left in the water or on the beach. In a high wind, a mooring rather than a beach should be chosen. If possible, a yacht mooring rather than an anchor (para 84) should be used.

(1) A bridle should be rigged from the bow mooring cleats on each float and the anchor line or mooring attached to the bridle. Water rudders should be retracted to permit the floatplane to weathercock in the wind. The stick or wheel should be pushed all the way ahead and lashed securely. The reason for this is that as the wind strikes the elevators the tendency is to push the nose of the plane down. This lessens the angle of attack and causes the plane to offer less resistance to the wind. It also tends to prevent the floatplane from leaving the water in strong gusts. Since the wind may change during the night, the mooring or anchor should be far enough from any obstacles so that the plane may swing completely around it in a circle whose radius is equal to the length of the mooring line. Before leaving the plane for the night, the pilot should be sure that the floats do not leak. A floatplane moored in this manner should ride out any wind with a velocity 10 miles per hour less than its landing speed.

(2) Sometimes it is possible to moor between two piles. The same control procedure should be followed as in *e*(1) above. A bridle may then be attached to the bow cleats and another to the stern cleats; a line should lead from the bow bridle to one pile and another line should lead from the stern to the other pile. The plane should be faced into the wind and enough slack left in the lines to allow for changes in tide. Another arrangement is to run lines from the wing struts to each pile if there are tiedown rings at the struts or if the ends of the struts are sufficiently rigid to warrant such an attachment.

Section II. AMPHIBIOUS FLOATPLANE TAKEOFFS

51. General

Normally, the minimum crew for amphibious operations is one pilot and one crewman. The pilot should give the crew the essential information on the weather and the destination. In addition, he should make as much information as possible available on the proposed area of operations by use of marine charts, tactical pilotage charts, and other pertinent publications.

52. Limitations

Operating limits in the appropriate operator's manual should be observed.

53. Safety Factors

In addition to the safety provisions contained in the operator's manual—

a. Extreme caution must be exercised when operating in congested areas where public water activities are in progress.

b. Personnel other than crew should not be allowed on the floats when the engine is running.

c. Crews should be conscious that flight performance is seriously reduced in the amphibious configuration; thus, careful consideration should be given to planning approaches and departures during water operation.

54. Amphibious Floatplane Daily or Preflight Inspection

- a. Check wheels and hubs for dents and cracks, and mud, grass, or ice fouling.
- b. Check tire pressures—
 - (1) Nosewheel tire pressure—60 psi.
 - (2) Main wheel tire pressure—50 psi.
- c. Check all tires for cuts, blisters, slippage, misalignment of wheels, and rubber deterioration due to grease or oil.
- d. Inspect brake line hose under main wheel yoke for signs of chafing or other obvious damage.
- e. Test brakes for effectiveness.
- f. Check exposed float areas for dents, corrosion, scrapes, etc.
- g. Check flooding of internal compartments by applying bilge pump to all standpipes.
- h. Check main float struts, spreader bars, and bracing wires for corrosion, security of fastenings, cracks, dents, or other damage.
- i. Check water rudder steering and retraction cables for excessive fraying or slackness; and rudders and connections for misalignment, corrosion, and cracks in castings. Test retraction and steering for ease of movement. Lower water rudders and check for—
 - (1) Free movement of handle.
 - (2) External movement of water rudders and flying rudder (when the water rudders engage, the flying rudder moves simultaneously).
 - (3) Cable tension and pulley movement.
- j. Check drainplugs to ensure that they are installed and secure.
- k. Check landing gear hydraulic fluid reservoir for correct fluid level.
- l. Check landing gear and oleo extension.

55. Inspection on Entering the Amphibious Floatplane

In addition to the normal aircraft check, observe selected position of the wheels on the amphibious floats hydraulic control unit. Also observe the position of the water rudders' retraction handle.

56. Postflight Inspection

- a. Check ladders for damage or corrosion.
- b. Ensure that paddles are in place and secure.
- c. When operating from salt water or areas of strong acid pollution, the entire floatplane should be washed down with fresh water as frequently as facilities are available, daily if possible.

57. Taxiing and Takeoff—Landplane

Climb flaps may be used for all landplane takeoffs and landings. To lessen the load on the nose gears, the pilot uses elevators on both takeoff and landing. Pilot procedures are—

a. *Taxiing.* In addition to the checks in the operator's manual, ensure that—

(1) Selector lever on the control unit for the amphibious floats (fig 9) is in the DOWN position and the indication on the wheels position indicator is a wheel.

(2) Water rudders' retraction handle is in the retracted position.

(3) Brakes are OFF. Test the brakes as soon as the landplane starts moving.

(4) Extreme care is used while taxiing and that only minimum braking is used. Keep the taxi speed up and use landplane momentum to advantage while taxiing. The amphibious brake discs are approximately half the thickness of the normal brake system and are extremely susceptible to warping when overheated. When proceeding from land operation to water operation, ensure sufficient brake cooling period to avoid brake warpage.

b. *Takeoff.*

(1) Open throttle slowly to takeoff power and note that the landplane accelerates more rapidly because of the quadricycle configuration. Maintain directional control initially by appropriate use of the air rudder.

Caution: The landplane is in a quadricycle configuration, giving better taxiing visibility. To prevent damage to the floats, however, more care should be taken to avoid grass and sand strips and rough or uneven ground. It is very easy to inadvertently taxi at excessive speeds; therefore, extreme care should be taken to reduce speed before entering congested areas.

(2) When taking off, hold the nose down until the takeoff airspeed increases to 1.2 times the stalling speed before easing the nose into climbing attitude.

(a) With flaps at TAKEOFF, the U-1A landplane will lift itself off at about 58 knots (65 mph).

Caution: If an attempt is made to raise the nose on takeoff when the airspeed is less than 48 to 52 knots (55 to 60 mph), the nose, once lifted, will tend to rise farther and must be checked. This is a normal nosewheel landplane characteristic and is easily controlled by elevator. If the nose is left down until the airspeed is 48 to 52 knots, this characteristic is absent.

(b) Allow the U-6A landplane speed to increase to 51 to 58 knots (60 to 65 mph) before applying a slight backward pressure to the control wheel. As the nosewheels lift clear of the ground, a slight forward pressure should be applied to the control wheel to maintain the takeoff attitude.

Caution: If an attempt is made to take off at the minimum speed of 50 to 51 knots (58 to 60 mph), the nose, once lifted will tend to rise and must be checked. This is a normal nosewheel landplane characteristic and is easily controlled by elevator. If the nose is left down until the airspeed is 69 knots (80 mph), this characteristic is absent.

(3) With wing flaps at CRUISE as the nose-wheel lifts clear of the ground, a slight forward pressure should be applied to the control column to maintain the takeoff attitude.

58. Taxiing and Takeoff—Floatplane

a. Starting Engine. If on the water with the engine shut down, be ready for an immediate start should an emergency arise. Prime the engine properly for the starting condition encountered. Avoid excessive priming as this will load the cylinders with raw gasoline, which has a tendency to wash the oil off the cylinder walls.

Note. After unsuccessful attempts have been made to start the engine, the cylinder walls must be recoated with oil by turning the propeller through three revolutions with the fuel selector OFF. The piston rings and cylinder walls, thus coated, will not rust if left for 1 or 2 days.

b. Engine Runup. The engine is prone to excessive magneto drop because of greater than normal exposure to low idle, wet plugs, and wet ignition harness. Use normal clearing procedure.

c. Wind Direction. Prior to takeoff, if the wind direction is not evident, determine it by raising water rudders and allowing the floatplane to weathercock into the wind.

d. Taxiing.

(1) *Checks.* In addition to the checks in the operator's manual ensure that—

(a) Wheels are selected UP and that the indication on the wheels position indicator is UP.

(b) Water rudders are retracted.

(2) *Slow taxiing.* Engine rpm can be reduced by using carburetor heat and alternately slipping the ignition switch positions. Forward motion is reduced by using full flap and carburetor heat.

(3) *Taxiing in a wind.* When taxiing into a wind, a turn to the left can be assisted by applying right aileron and holding until the wind is abeam. The application of left aileron will help carry the upwind wing around in the turn. The effect is most pronounced with full flap. The reverse is true for a turn to the right.

(4) *On-the-step taxiing.* Avoid on-the-step taxiing downwind. Taxi on the step into the wind with water rudders up and with flap set on climb.

e. Takeoff. Perform final takeoff check—normally, flaps should be at the takeoff setting to reduce takeoff

run and excessive water pounding. No-flap takeoffs are not permitted. With water rudders retracted, open throttle smoothly and maintain direction with the floatplane rudder.

(1) Allow the U-6A amphibious floatplane to fly off the water at approximately 58 knots (65 mph).

(2) Allow the U-1A amphibious floatplane to fly off the water at approximately 43 to 48 knots (50 to 55 mph).

(a) Hold floatplane close to the water until airspeed has increased from 61 to 65 knots (70 to 75 mph) before starting to climb.

(b) In takeoffs in limited areas, commence climb at 52 knots (60 mph).

(c) Cylinder head temperature may become excessive on warm days. Use takeoff power and then maximum continuous power until clear of terrain, then fly above obstructions. Set flaps midway between cruise and climb, reduce power to 1,800 rpm, and reduce rate of climb to increase airspeed to 80 knots or better. This procedure keeps cylinder head temperature within limits, as ambient temperature increases.

(3) On extremely rough water, avoid excessive float "pounding." Careful surface evaluation (app. B) will enable the pilot to select a relatively smooth takeoff run. When thrown prematurely into the air by a wave crest, dropping heavily into the oncoming wave can prove disastrous to the float hulls, spreader bars, and rigging. For these reasons, areas with large waves or swells are to be avoided.

(4) Calm water tends to increase the takeoff run, due to suction forces on the float hull. It may be necessary to "lift" the floats one at a time by careful manipulation of the ailerons.

(5) On hot and relatively calm days, heavy takeoffs may be aided by the initial use of cruise or climb flap followed by the use of normal takeoff flap as the speed increases. Takeoff flap at the beginning of the takeoff run provides a measurable amount of drag.

f. Crosswind Takeoff. Crosswind takeoffs may be carried out to the normal crosswind limits; however, consideration should be given to a flap selection less than that required for takeoff. Use of water rudders during the initial acceleration period is permissible to maintain directional control. An approaching gust may be seen well in advance by the ripple it causes on the water's surface. This can be useful in judging the takeoff point. Restricted area takeoff runs may be lengthened by planning a dogleg run. The pilot should—

(1) Anticipate the need for crosswind technique when operating in the vicinity of islands and hilly or irregular shorelines, as local terrain may cause bumbles or a change in wind direction.

(2) Always select a takeoff path on the lee side of the lake, as a crosswind blowing down over the

shoreline may cause downdrafts which could impede climb performance.

(3) After takeoff, reduce power to maximum continuous power for the initial climb.

59. In Flight

In flight, whether climbing, cruising, or descending, the effects of the amphibious floats are the same as those encountered with normal floats. To improve

the flight characteristics, wheels are always retracted before water taxiing and taking off.

a. Rough Air. Caution is advised when operating at lower levels (as in the vicinity of hilly shore terrain), due to currents of rising and descending air. As a general rule, add 5 knots while maneuvering.

b. Stall Speed. Stall speed is unchanged by the addition of floats. However, sink rate is higher and ground effect during roundout is greatly reduced.

CHAPTER 7

FLOATPLANE AND AMPHIBIOUS FLOATPLANE LANDINGS

Section I. FLOATPLANE LANDINGS

60. Landing-Area Inspection

Before landing, carry out an area inspection. Look for approach and departure paths, floating logs, debris, imbedded stumps, submerged rocks and shoals (particularly near points of land), submerged docks and rock cribs, etc. Evaluate the wind and general water surface. Whitecaps indicate 12 knots or better wind and the whitecaps collapse onto the upwind side of the wave. Evaluate the docking, beaching, or buoying while still airborne, as the terrain will look considerably different at water level. Plan the departure with consideration for a wind shift. A wind shift can drive debris back onto a lake. Normal landings should be with flaps at setting for landing. Landing runs should be kept to a minimum to reduce strain on floats and struts. No-flap landings are not recommended. Swells found in large bodies of water are dangerous and difficult to see. These swells are caused by the wind and they can persist many hours after the wind has abated or shifted. Careful consideration should be given to the size of a lake, as the landing run is considerably less than the takeoff run. Landing should be made only in an area that has sufficient space for takeoff. Caution is advised when operating on busy lakes, as motor boat operators tend to be curious and unpredictable. After landing, unless an immediate takeoff is intended, turn off all nonessential electrical and radio equipment.

61. Classification

Water landings may be classified as three general types:

a. Full Stall Landing for Rough Water. If the water is rough, particularly with no wind, the steepest possible stall with maximum flap should be used. The purpose is to avoid clipping a wave with the nose of the floats, this might cause structural damage. In very rough water the floatplane will have a tendency to be thrown in the air nose high. To offset this tendency, it may be necessary for the pilot to apply forward elevator pressure.

b. Semistall Landing for Moderately Rough to Calm Water. Stall landings are always safe but somewhat unpleasant on reasonably calm water, and under normal conditions a semistall is recommended. In a

semistall landing, the tail and step of the floats touch the water more or less simultaneously, resulting in a slightly faster landing than the conventional three-point landing on wheels.

c. Landing on Glassy Water. As it is impossible to judge the surface of the water, all glassy water landings should be made using recommended technique for that type of floatplane (para 66).

62. Determining Wind Direction

The floatplane aviator makes most of his landings without assistance of control towers or windsocks. A strip of glassy water along one edge of a lake indicates the upwind side; even a low bank will cause the wind to skip out a short distance from shore before it descends and ripples the surface. Streaks on the water indicate wind direction and are parallel to the wind. If whitecaps are present, they appear to move against the wind, but actually the waves move from under the foam as they travel downwind. Normally, the waves form at right angles to the wind; but in a shifting wind, waves will not change direction at once, and only the streaks can be depended upon to give correct wind direction. Boats at anchor may indicate wind direction, but currents and tides may make them completely unreliable as indicators, especially if they are deep-keeled sailboats.

63. Landing Rules

Landing rules are as follows:

a. Determine water depth. Fly over clear water and observe depth. Beware of—

(1) *Muddy water.* It may conceal sandbars.

(2) *Still water.* It may be shallow with rocks just below the surface.

(3) *Patches of floating vegetation.*

(a) Waterplants (e.g., lilies) seldom grow in deep water.

(b) Floating logs may be concealed beneath the vegetation.

(c) Taxiing or takeoff will be impeded.

(4) *Glassy water.* Landing is difficult (para 66).

b. Never land toward a landmass or dock—you might sometimes need to make a go-around or misjudge needed stopping distance.

- c. Avoid storms and the open sea.
- d. Touchdown at minimum speed to reduce stresses on the floats.

64. Landing in Normal Water

Landing upon water other than that which is glassy and not too rough is similar to a ground landing; the major difference is a greater latitude in touchdown attitude. A three-point attitude (full stall) is safe and usually best. If the water is only slightly ruffled, a slight tail-high attitude (semistall) will produce a smoother landing eliminating a pitchdown as sustaining force is transferred from wings to float bottoms. As in takeoffs, the float keels provide strong assistance to directional stability in the landing run. Water resistance provides smooth, rapid deceleration. As planing speed is lost, the floats settle deep into the water and the plane eases to a short stop. The stick should be full back throughout the landing run.

65. Landing in Rough Water

Rough water requires minimum speed at initial contact (full stall landing). Since this is one of the objectives in short-field training, Army pilots should meet no difficulty in the basic technique. When the water is extremely rough, the basic technique may be projected into a power stall landing. Since the exact point of contact on the slope of the first wave cannot be foreseen, the pilot should be ready to use throttle to recover from one or more undesirably hard contacts. Once a moderate bounce has been achieved, the throttle should be eased off. Following this, a series of diminishing bounces will take place until the floats settle fully on the water. Before the pilot attempts to land in extremely rough water, he should reconnoiter the surrounding area for a more sheltered spot. (Safety-conscious pilots will tolerate the inconvenience of a long taxi trip home after landing in the nearest available protected waters.)

66. Landing on Glassy Water

If it can be avoided, landing should never be made on absolutely glassy (dead smooth) water. To judge altitude above a glassy water surface is difficult; even the most competent pilots may be deceived, and being mistaken on this point has been the cause of many accidents. If a landing is unavoidable on a glassy surface, it should be made close to buoys, boats, or other objects which will provide a visual reference on the water surface; if not available, floatable objects may be thrown overboard to provide this visual reference. Observation should be directed to such references, and not to the water ahead. If landing in a large, open area of glassy water is unavoidable, the power approach procedure must be used. Because of depth perception difficulties, an accurate roundout is impossible. The landing is approximately in the plan-

ing attitude. This is sometimes referred to as a step landing. This is the only sure, safe method to follow in case of glassy-water landing conditions. If the engine fails over glassy water, the pilot should head for any available object that will provide visual indication of the water surface. These landings should be practiced under light wind conditions until the pilot is proficient. The roundout is judged by looking at the object—not the water. The pilot should not use more than 10° flap and he should maintain the airspeed recommended for 10° flap. He should also concentrate on keeping the wings level.

a. *U-6A Floatplane Landing on Glassy Water.* If it is necessary to land on a glassy-water surface, the floatplane should be flown to touchdown with flaps at CLIMB, airspeed of 65 miles per hour, and power for a rate of descent of 100 to 150 feet per minute. The pilot should maintain this condition until contact with the water is made, then he should close the throttle. During the approach and landing, no visual reference should be made to the water except to ensure that no obstructions exist. Shorelines, docks, etc., should be used as points of reference from which the landing procedure can be commenced. It is obvious that this type of landing requires appreciable more space than a landing made under more normal conditions.

Warning: As judgment of height above glassy water is impossible, the pilot must not attempt a STOL U-6A floatplane landing on glassy water.

b. *U-1A Float Plane Landing on Glassy Water.* A normal visual approach should be carried out from 150 to 200 feet down (or lower, if a *positive* visual reference to altitude is available). At this point, the pilot should make a positive transition to instrument flight. From this point to touchdown, the pilot flies the floatplane on instruments at a rate of descent of 150 to 200 feet per minute with airspeed 3 to 5 knots below normal approach speed. If a copilot or crewman is available, he assists the pilot by calling altitude and maintaining a lookout for obstacles. When the deceleration of touchdown is felt, the pilot closes the throttle and applies normal stick back pressure. The pilot should—

- (1) Set flaps to CLIMB position.
- (2) Trim at 60 miles per hour and approach at 65 miles per hour by forward pressure on the stick.
- (3) Use power to maintain a 200-foot-per-minute rate of descent.
- (4) Close the throttle on contact with the water.

c. *U-10 Floatplane Landing on Glassy Water.* When landing the U-10 floatplane on glassy water, total reliance must be made on the flight instruments until touchdown. Safe landings can be accomplished with reference to aircraft flight instruments and with a 350- to 400-foot-per-minute rate of descent.

67. Crosswind Landings

Crosswind landings are occasionally useful in confined waters or to take advantage of smooth water close under a sheltering shore. The procedure is exactly as on land. Weathercocking forces will be experienced soon after water contact and, for this reason, it is important to drop the water rudders and be ready to apply downwind rudder as soon as contact is made. Crosswind landings should not be attempted in high waves, as there is danger of getting the upwind float on a crest and the other in a trough and allowing the wind to get under the upwind wing.

68. Downwind Landings

Downwind landings are seldom attempted under any but light wind conditions. No special technique is involved in downwind landings other than to bring the floatplane in as slowly as possible, and to drop the water rudder promptly to forestall an inadvertent weathercock. The pilot should be prepared for the possibility of the floats having a tendency to drag or tip up slightly forward.

69. Landing on Swells

Landing on swells is handled like taking off from swells (para 46), in that the landing should be parallel to the swells and preferably along a crest. Landing across swells may lead to uncontrollable porpoising.

70. The Damaged Float

Puncturing a float is not uncommon on landing. If the jolt is severe, the plane should be kept on the step and run up to a ramp or beach, or to known shallow water. Punctures also may occur on takeoff, especially during the latter part of the run when speed is high. In such case it is usually best to become airborne and fly to an area suitable for beaching or salvage. A landing run may be possible which will terminate on a ramp or beach or on shallow water. It is rare that a damaged float lacks sufficient buoyancy to contribute some flotation. If a float appears to be in danger of complete immersion, the pilot should transfer passengers and movable cargo out on the opposite wing to counterbalance the damaged float. Thus the plane may be able to taxi to shore or at least to remain afloat until help arrives.

71. Night Landings

Landings at night are simple when lights are available on buoys, docks, or boats, or in buildings along the shore. The main precaution is to avoid overshooting, since light is of negligible value if it flicks past the wingtip before the water is contacted. Landing

into or across a path of moonlight on the water is almost like landing in the daytime; however, a moon behind the tail is little or no help.

a. Landing in unlighted areas is executed as on glassy water. A power approach should be initiated, a gradual rate of power descent set up, and the floatplane gradually eased down until water contact is made.

b. Landing lights should not be used for night water landings. They blur the vision (by reflection) and are no help in finding the water. Their proper use in a floatplane is for taxiing and docking.

c. A reconnaissance should be made prior to setting up the landing approach. Objects on the water can often be discerned, even on dark nights. The reconnoitering altitude should be high enough to allow for limitations of night depth perception and for clearance of ship and sailboat masts.

72. Emergency Landings

a. *Over Water.* For aircraft emergency procedures over water, see FM 20-151 and appendix B. Emergency situations occurring within gliding distance of water usually present no landing difficulty. Although there is a broad safe range of landing attitudes for the floatplane from tail high to tail low, it is very important to select the correct type of landing for varying water conditions (para 61). For engine failures, an anchor and a paddle are useful after the water landing has been completed.

b. *Over Land.* Over land and with a smooth field available, it is often possible to land the floatplane without damage. Snow-covered ground is ideal for both landing and takeoff. The landing should be slightly flat, a bit fast, partially on the step, and directly into the wind. A small amount of power assures that the floatplane will land in a slightly flat attitude. Just before skidding to a stop, the tail will begin to rise, but the long float bows will check the rise before it goes too high. After such an emergency landing, takeoff may be possible on grass which has been soaked down, or upon a short runway of wooden laths soaked in used engine oil. The main problem is to start the plane moving. After a little speed is attained, the keels will slide.

73. Open Sea Landings

Current Army floatplanes are not designed for open sea landings, and should not be used for this purpose except under the most favorable conditions. If the mission is to accomplish a rescue, the wisest plan may be to remain airborne and orbit, dropping whatever aids are available and radioing for assistance. If an open sea landing cannot be avoided, the techniques in appendix B should be followed.

Section II. AMPHIBIOUS FLOATPLANE LANDINGS

74. Landing

Before the approach to land, the pilot must consider his intended landing area and take action accordingly. During the approach to land, the pilot maintains the airspeed at 1.3 times the stalling speed. For landing, the selector lever on the control unit for the amphibious floats (fig 7) must be in the selected UP or DOWN position and the handpump operated until the desired position (UP or a wheel) is shown on the wheels position indicator. To operate—

a. The quadrant engaging arm on the selector lever is pressed in to release the catch from the quadrant before selector lever is moved from the forward UP position to the rear DOWN position or vice versa. The catch must reengage with the quadrant at the completion of the selection.

b. With the selector lever in the DOWN position, an extension on the lower part of the selector lever engages a protruding solenoid plunger. This prevents

the wheels from being selected UP when the weight of the amphibious floatplane is on the wheels.

c. When the amphibious floatplane weight is not on the wheels, a switch on the main gear retracts the solenoid plunger allowing the lever to be selected UP. When airborne, if the plunger does not retract and it is desired to raise the gear, the plunger can be depressed manually.

75. Landing on Land

For landing, the wheels must be selected DOWN (fig 7 and para 30e) and locked and the water rudders retracted. Excessive play in nosewheel oleos may cause shimmy on landing.

76. Power-Off Landing

A power-off landing is permissible; however, a touch of power, down to just above the touchdown point, provides more positive control. Approaching gusts or eddies may be seen well in advance by the ripple on the water's surface.

CHAPTER 8

SEAPLANE BASE FACILITIES AND GROUND HANDLING

Section I. SEAPLANE BASE FACILITIES

77. General

Standard seaplane base facilities include fixed docks, floating docks, ramps, marine railways, and moorings. Bases may be equipped with a hoisting crane for lifting the seaplane from the water. Beaches, docks, ships and boats, or unprepared anchorages may serve as a base. However, boats and unprepared anchorages are least favorable and should be used only for brief refueling and passenger or cargo stops. Anchorages require an anchor with an adequate length of tested line and, in remote areas, an inflatable boat.

78. Fixed Docks

a. Taxiing Approach. If possible, the approach to a docking facility should be made upwind (or up-current, if the wind is negligible). It is normally possible to approach a dock upwind, since three sides are available for approach. Even if the wind is blowing directly toward the shore, it is often possible to taxi downwind to the side of the dock and then weathercock into the desired docking position. In light wind conditions, the engine must be cut in advance to allow the momentum to carry the floatplane gently up to the dock. The ideal procedure is to taxi close enough alongside the dock to permit a ground crew helper to grasp the wing or to have the pilot or passenger step from the float to the dock and moor.

(1) Crosswind taxiing approaches should be avoided whenever possible. Considerable power is required to overcome weathercocking, and the speed on arrival may drag a helper off the dock. Also, an off-shore crosswind may weathercock the plane at the last moment and cause the float bows to straddle the corner of the dock, resulting in damage to the propeller and/or the dock.

(2) Downwind taxiing approaches require precise judgment, but are often preferable to crosswind approaches, especially with an onshore wind. The face of the dock should be approached straight downwind until close in; then the throttle should be closed and rudder applied to initiate a weathercock, swinging the wing over the dock at a reasonable speed (fig 17).

b. U-1A Floatplane Sailing Approach, Docking, and Departing.

(1) *Sailing.* A crewman must be stationed on the float while sailing. Directional control may be obtained by use of rudder and ailerons. When the crewman facing aft calls "Left," apply left rudder and right aileron. This causes the tail to move to the crewman's left and vice versa. Backward sailing speed should be kept relatively low. With engine idling, use power as a brake. U-1A floatplane sailing is accomplished with—

- (a) Full flap.
- (b) Water rudders up.
- (c) Engine at slow idle to shut down.
- (d) Doors open (if required).

(2) *Docking.* The U-1A floatplane is large and very susceptible to strong wind conditions. The floatplane weight increases the momentum potential, and severe float damage may result from what might have been a slight bump. For docking, follow this pilot technique:

(a) Make an inspection pass if at an unfamiliar dock. Check for tiedowns, underwater obstructions, nails, obstructions on dock (flagpoles, etc.), and the exit path. Never attempt a docking maneuver in an area where there is no exit path.

(b) Be aware of danger to curious onlookers, as both the wing and tail surfaces usually overlap the dock by several feet. Only qualified personnel should be allowed to assist in the docking. The tie-down rope should not be thrown to persons standing on the dock, as serious injury could result.

(c) Station the crewman on the float adjacent to the cockpit door. Close the rear doors to allow the crewman unobstructed movement on the float. Warn him not to proceed forward of the cockpit door while you are maneuvering with the engine operating. Maintain loud verbal communication with him to be sure he fully understands your instructions.

(d) Change direction and make a second pass at the dock. If necessary, install bumpers before docking. Prior to docking, make dead and live magneto check.

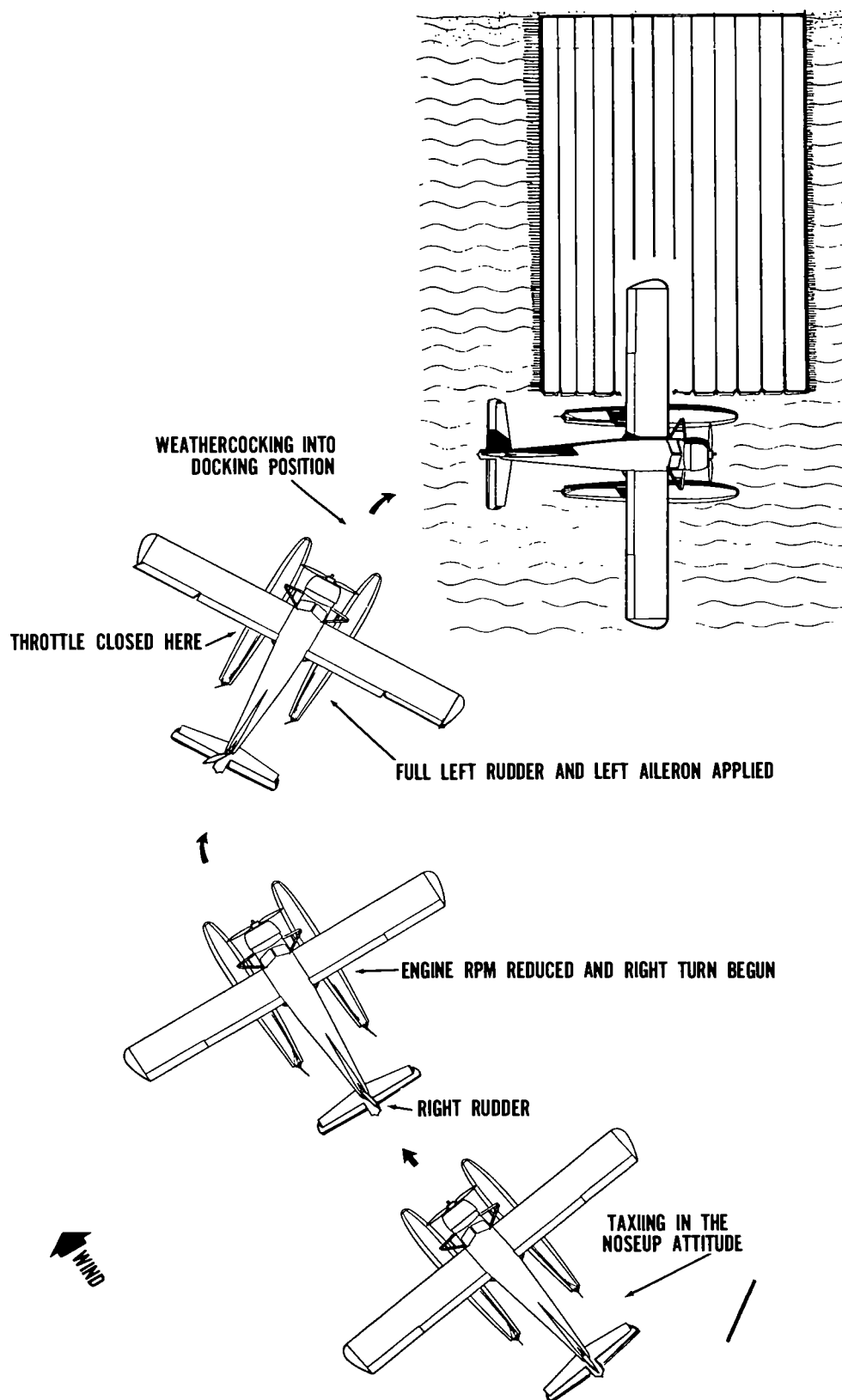


Figure 17. Approach to a dock with onshore wind.

(e) Approach at safe speed, using throttle, flaps, opposite aileron, carburetor heat, magneto "blipping," and water rudders to control direction and speed. Aim for a position approximately 6 inches away from the dock.

(f) When docking is assured, shut down the engine. Advise the crewman "Switches off," retract flaps and water rudders, and assist him as required.

(g) In the U-1A and U-6A, when docking on the right float, sit in the right seat.

(3) *Departing.* When departing (after engine running), cast off appropriate ropes and push off. Ensure that ventral fin will clear the dock. Lower water rudders when clear of the dock.

c. *Crosswind Sailing Approaches.* Crosswind sailing (fig 18) is a useful method of approaching docks

at a slow speed and with accurate control. Downwind (backward) sailing is occasionally employed (the objective usually being a side of the dock), but control is less effective, and there is danger of striking the tail against the dock.

d. *Departure.* In leaving a fixed dock or a floating dock, if a helper is available, it is desirable to have him swing the floatplane so that it is pointing toward open water and hold it in that position until the engine is started. If there is no assistance at hand and the plane is moored with the bows of the floats against the dock, it must be cast off and allowed to drift back far enough to make a turn without striking the dock before the engine is started. Since the engine may fail to start, consideration should be given to the possibility of drifting backward into obstructions.

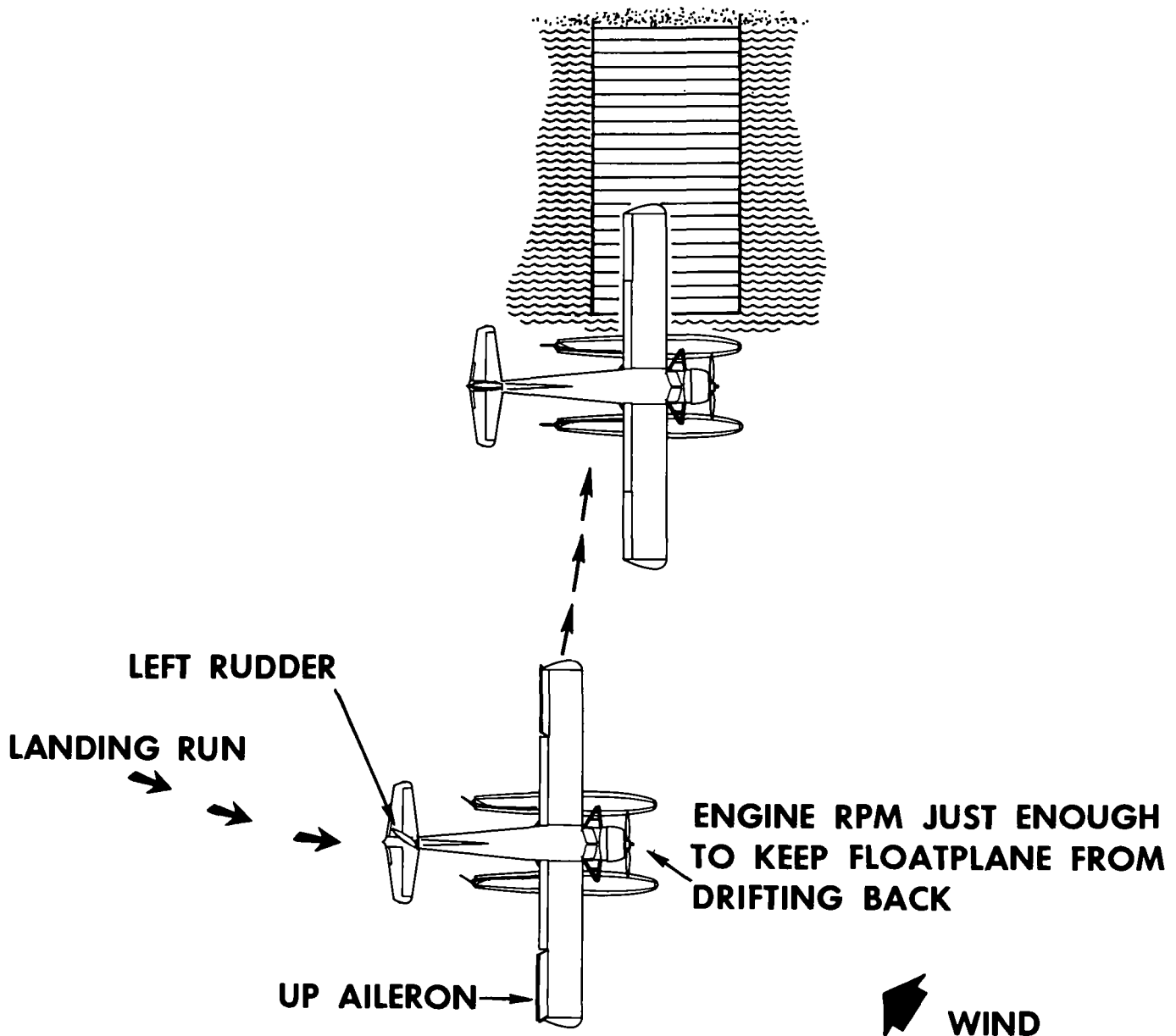


Figure 18. Crosswind sailing approach to a dock.

79. Floating Docks

A floating dock is the minimum type of seaplane facility. It is usually constructed of planking supported by discarded airtight POL drums and is connected to the shore (or a fixed dock) by a walkway held in place by booms or mooring cables. A floating dock is convenient, but it provides no means of beaching a floatplane for repairs and inspections or during stormy weather. Most shore installations supplement the dock with an inclined ramp (para 80) or, infrequently, a marine railway (para 81). Float facilities must provide space for the operation of all floatplanes and give anchor security to those subjected to high winds and/or rapid water level changes. On rivers, consideration must be given to the flood stages and receding low water depth. A reconnaissance of the water area may disclose floating dock locations that provide—

- a. Easy vehicular access to docks.
- b. Adequate gravity refueling facilities.
- c. Water of sufficient depth.
- d. A clear area surrounding docks to allow thorough inspections and maintenance.

Caution: Ground crew helpers on dock or ramp should always beware of floatplane propellers. Passengers should never be allowed to go aboard or leave while the engine is running.

80. Ramps

A floatplane ramp is a sloping platform partially submerged under the surface of the water. It has a dolly with a winch (para 91d). The ramp should extend from well above high water to a depth exceeding the draft of the loaded floatplane. If the ramp is of wood, the floatplane can be slid up or down it on the keels of the floats, provide the surface of the ramp out of the water is wet. A surface of wooden planks is laid crosswise and is of sufficient width to permit minor inaccuracies in floatplane approach. Concrete-surfaced ramps are occasionally available, but they ruin float keels; wheeled beaching gear must be installed before contact with this type ramp.

a. *Approach.* Ramp approaches are easier when the wind is blowing offshore. When the floatplane approaches a ramp (or other docking facility) on other than an upwind course, allowance must be made for weathercocking action. A common fault during this approach is to close the throttle too soon because of the fear of striking at too high a speed, with the result that the floatplane weathercocks around out of control just at the moment when ramp contact should be made. If a floatplane is traveling along at about 700 or 800 rpm and is allowed to hit the runway without reducing speed, there will probably be less shock than if the throttle is cut about 20 feet offshore. This is because the bow waves cush-

ion the floats when the floatplane strikes at constant speed. If power is abruptly reduced, the bow waves shift aft and tend to lift the stern. The floatplane then moves forward with bows down, just at the moment when ramp contact is made. Also, maintaining a slow but constant rudder movement from side to side ensures that the floatplane will respond when required.

(1) *Onshore wind approach.* Onshore winds necessitate an approach directly downwind whether or not the course is at an angle to the ramp. Before making ramp contact, the plane must be in straight alignment with the ramp. A well-timed touch of the rudder will weathercock the plane in line just as the floats make contact with the ramp. If the turn is started too soon, it is best to open the throttle and hit hard. One-float contact with a quartering tailwind will result in abrupt weathercocking, with possible serious damage, especially if a keel happens to drop into a crack between the planks. The approach to the ramp should be made with enough speed downwind to maintain control. This speed should be continued until the floatplane actually strikes the ramp and slides up it. Then the bow waves that precede the floats will cushion the floats on the ramp.

(2) *Downwind approach when wind parallels shore.* The down wind approach is also used when the wind parallels the shore (fig 19). The weathercocking turn may be as much as 90 degrees. This is generally preferable to an upwind approach involving a high speed, high rpm, turn out of the wind, and a violent contact with the ramp. Normally, the best procedure is to taxi directly downwind until near the ramp. When the floatplane is in such a position that it will weathercock onto the ramp in position to slide up it (fig 19), engine rpm should be reduced. After weathercocking onto the ramp, power should be applied until the plane is pulled completely clear of the water. If the wind is very high, this maneuver should not be attempted without the presence of a helper on the ramp. If the ramp is wet and slippery, the plane may be blown sideways across the ramp and off the leeward side. Only experience will enable the pilot to tell just when to add power; consequently, the maneuver should not be attempted until the pilot has acquired high proficiency in handling the floatplane. In an extremely strong wind, the safest procedure is to taxi upwind to the ramp and near enough for a helper to attach a line to the floats. The plane then maybe left floating or, by means of the lines, maneuvered into a position from which a tractor can haul it up the ramp.

b. *Departure.* If the floatplane is on a wooden ramp, all that is necessary is to wet the ramp, point the plane down it, and open the throttle. If the ramp is steep, the controls should be pushed ahead and the throttle opened and closed quickly to provide a blast of air on the tail just as the floats slide into the water.

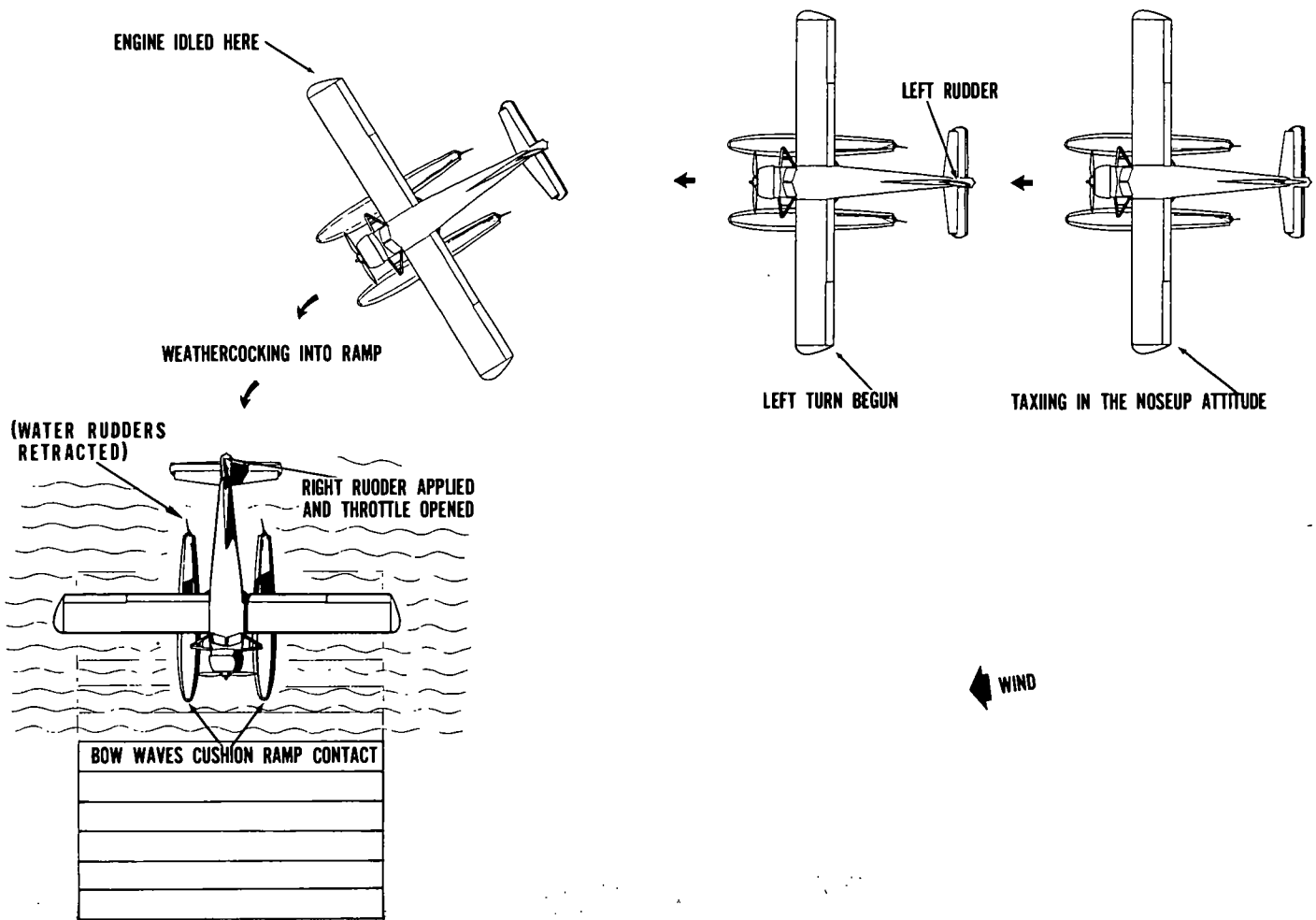


Figure 19. Approaching a ramp with a crosswind.

Otherwise, as the bows begin to be supported by the water, they will rise and the sterns of the floats will strike the ramp violently. The water rudders should be up while sliding off the ramp.

81. Marine Railways

Marine railways are sometimes built at seaplane bases in place of ramps. The docking techniques are similar to those employed with ramps, with a few added precautions. Before the final approach, the pilot must determine that the platform has not been placed so far up the tracks that the depth of water at the approach end is inadequate. He also must guard against an excessive blast of power as he leaves the water, since this may carry him over the far end of the railway platform.

82. Moorings

Moorings similar to those used in yacht basins are often available at a seaplane base. A proper mooring fixture consists of a heavy weight on the bottom (usually concrete or iron), connected by a chain or cable to a floating buoy. Some buoys are padded and provide a fixed tieup ring. The chief disadvantage

of moorings is the difficulty of loading or unloading. Since a mooring can normally be approached from any angle, selection of the ideal (upwind) approach is usually possible. For the pilot's transport independent of a shore party, an inflatable rubber boat may be carried aboard the floatplane. If the floatplane is moored to an offshore buoy, lighting regulations must be complied with (para 7, 8, and 10).

83. Beaches

Sand beaches provide convenient unprepared docking facilities for floatplanes. However, sand is abrasive, and the highly corrosive aluminum alloy in floats is only protected by a thin sheet of pure aluminum and a light coating of paint. Sand abrasion removes these protective coatings quickly and exposes the aluminum alloy. If it is necessary to put the plane on the beach, the nature of the shore should be determined before contact is made. If it is rocky, there is danger of damage to the bottom of the floats, particularly if waves of appreciable magnitude are rolling in. If possible, approach to a beach should be made by sailing backward with the water rudders up. Since the aft bottoms of the floats do not dig into

the beach as deeply as the forward bottoms, a backward approach causes much less abuse to the floats.

a. Blasting up on beaches with engine power should be avoided. The best procedure is to cut the engine before shore contact, sailing or drifting the last few feet.

b. If a helper is available on shore, the pilot can swing a wingtip over the beach within reach of the helper. A good push on the wing by the helper will pivot the tail within his reach. He can then pull the floatplane to the beach tail first (water rudders up), allowing the occupants to reach land from the aft end of a float. In the absence of a helper, shore is reached by paddling or wading.

c. The floatplane should never be left unattended unless at least a tail line is fastened to some solid object ashore. Moderate action of the water will rapidly wash away the sand beneath the floats and set the floatplane adrift.

d. The floatplane should not be left where waves are above sea state 2 (para 3, app B). These waves will alternately pick up and drop the floatplane with possible risk of serious damage.

e. If the floatplane must be beached, planks should be placed across the projected path of the keels and wetted down before the plane is hauled out.

Caution: An incoming tide will float a shore-grounded plane within a few minutes. Also, a receding tide may leave the floatplane stranded 30 or 40 feet from the water in a few hours.

f. If it is necessary to leave the floatplane on the beach overnight, it should be tied in the manner described for landplanes, using stakes driven into the ground. In case of severe winds and as an emergency procedure, the floats may be filled with water. This will hold the plane in almost any kind of a blow but necessitates pumping out the floats the next morning. When using the beach, consideration also must be given to the tide as the buoyancy of the float is usually sufficient to pull tiedown stakes out of the ground. Furthermore, if the plane is half in and half out of the water, the waves may bounce it around on the beach and damage the floats as well as the rest of the structure.

84. Unprepared Anchorages

Using unprepared anchorages, i.e., anchoring by means of the equipment carried in the floatplane, is an emergency measure except for short stops. Due to the type of bottom or the depth of the water, an anchor may drag and allow the plane to be blown ashore. If a yacht mooring is unavailable, the conditions of the bottom should be determined from local residents if possible. Otherwise, a check may be made by dropping the anchor, pulling it up again, and trying to determine the nature of the bottom from what may remain on the anchor. Mud or sand usually will hold quite well. A rocky bottom is undependable. In anchoring, a liberal length of line should be allowed (about eight times the depth of the water) and the anchor dropped where there is ample room for the floatplane to swing in any direction. Making the plane fast is the same as tying up to a mooring. After the floatplane has drifted downwind enough to take up the slack, the pilot should give a few hard tugs on the line to assure that the anchor is holding securely to the bottom. This may also help to bed the anchor further. When necessary to anchor overnight, the pilot should remain aboard the plane.

85. Other Facilities

When stopping at a high dock, seawall, ship, or large boat with considerable freeboard, the only feasible approach is noseon. This is a precarious maneuver and requires favorable wind and water conditions. Lacking these, it is best to anchor nearby and complete the mission by boat. Tying up to the above facilities is accomplished by means of a pair of wing lines, pulled taut, so that the bow bumpers ride snug against the dock or other surface. Seat cushions may be used as emergency fenders if the nose bumpers tend to pound or catch on projections.

Warning: An inexperienced person may attempt to cast a line to the approaching floatplane. Since casting lines usually have small padded weights on the end, the pilot must cut the engine instantly to avoid propeller damage or worse.

Section II. GROUND HANDLING

86. General

Proper handling of the floatplane between flights involves specialized procedures both for security against the weather and for the routine movement on shore. The procedures given below supplement the unit's SOP precautions for landplane pilots and crews.

87. Tying Down on Shore

Tying down is done by means of the wing and tail tiedowns, with the plane in normal flight attitude. The aft portions of the floats are blocked up to prevent seesawing on the step, which is located almost at the center of balance. Controls are locked or tied with elevators down. Tail into the wind is preferred. When

necessary to leave the plane on a beach, follow the procedures of paragraph 83. The plane should be positioned well above high water.

88. Tying up to a Pier

A single pier is a poor place to tie up to for an extensive length of time, since the only possible position is noseon against the pier. This position exposes the floatplane to the wind. However, a slipway between two piers provides good shelter. The floatplane should be tied in the middle of the slipway by two wing lines, or one line may be tied to the nose and one to the tail. In coastal waters, enough slack in the lines must be allowed for the rise and fall of the tide.

89. Tying up to a Floating Dock

A well-padded floating dock is adequate for tying up alongside in moderate weather. Lines should be firmly secured at bow and stern of the inboard float. If near ship traffic, large wakes may roll the plane and cause the inboard wing to strike the dock unless a dock attendant is there to steady the floatplane. Since strong winds can severely damage a floatplane tied to a dock, one end of a dock may sometimes be depressed and the floatplane hauled aboard to permit tiedown on top of the dock. For this purpose, some floating docks have been designed with a short ramp section on one or both ends.

90. Mooring

Mooring means typing up to a permanent fixture in the water (para 82). The light anchor carried in the floatplane is unreliable as a mooring device.

a. Approaching. The floatplane path should place it at the mooring buoy on the outboard side of the float. The engine should be cut when the momentum will bring the buoy within easy reach, with proper allowance for wind and/or current. The pilot or passenger should have a mooring line ready to pass through the ring of the buoy while the buoy remains within reach. In rough weather, the floatplane end of the line should be made fast in advance so that the free end can be passed through the ring and snubbed promptly. A canoe paddle equipped with a hook for engaging the mooring ring is a convenient accessory at this time.

b. Securing. If the floatplane is to be left at a mooring a considerable length of time, the pilot must assure that the floats are watertight. A bridle should be rigged to the bow cleats or to the base of the forward struts and spreader bars. Bush pilots often prefer to moor with a single line to the propeller hub, on the theory that the downward pull will provide extra security in rough weather. Due to weathercocking, a moored floatplane will safely ride out winds up to and above its stalling speed. In any case, control surface

locks should be installed (elevators full down) to prevent any tendency of the floatplane to fly off the water in a strong wind or storm. Additional security may be provided by hanging a pair of buckets or cans from the wing tiedown rings, just below the surface of the water. The cans will not prevent weathercocking, but the rising wing is countered by the full weight of the water-filled cans. In winds which are higher than stalling speed, the pilot may stay aboard at the controls with the engine running.

c. Water Rudders. Water rudders should be retracted so that the floatplane can weathercock and face directly into the wind. If the water rudders are not retracted, heavy wind conditions may cause the floatplane to flip.

91. Floatplane Handling on Shore

Floats are stressed to resist fluid forces distributed evenly over a large surface. Concentrated stresses exerted by jacks or single rollers are apt to cause permanent kinks or twists which seriously impair hydrodynamic efficiency and watertightness. A floatplane may be dragged straight ahead or straight back on its floats, so long as it is on a smooth, nonabrasive surface and the weight is distributed evenly along the length of both keels.

a. The smaller size floats have built-in axle tubes near the step. These are engineered to take the full weight of the floatplane when mounted on a pair of axles with a wheel on either side of each float (four wheels in all). Omission of the inboard wheels will result in bent spreader bars and damaged fittings. If only two wheels are available, a long single axle must be used.

b. Larger floatplanes (U-1A and larger) are equipped with attachment fittings to accept a factory designed beaching gear. The beaching gear is generally installed and removed in the water.

c. If the same gear must serve several floatplanes, the planes should be blocked up in their tiedown spots for easy removal and reattachment of the gear.

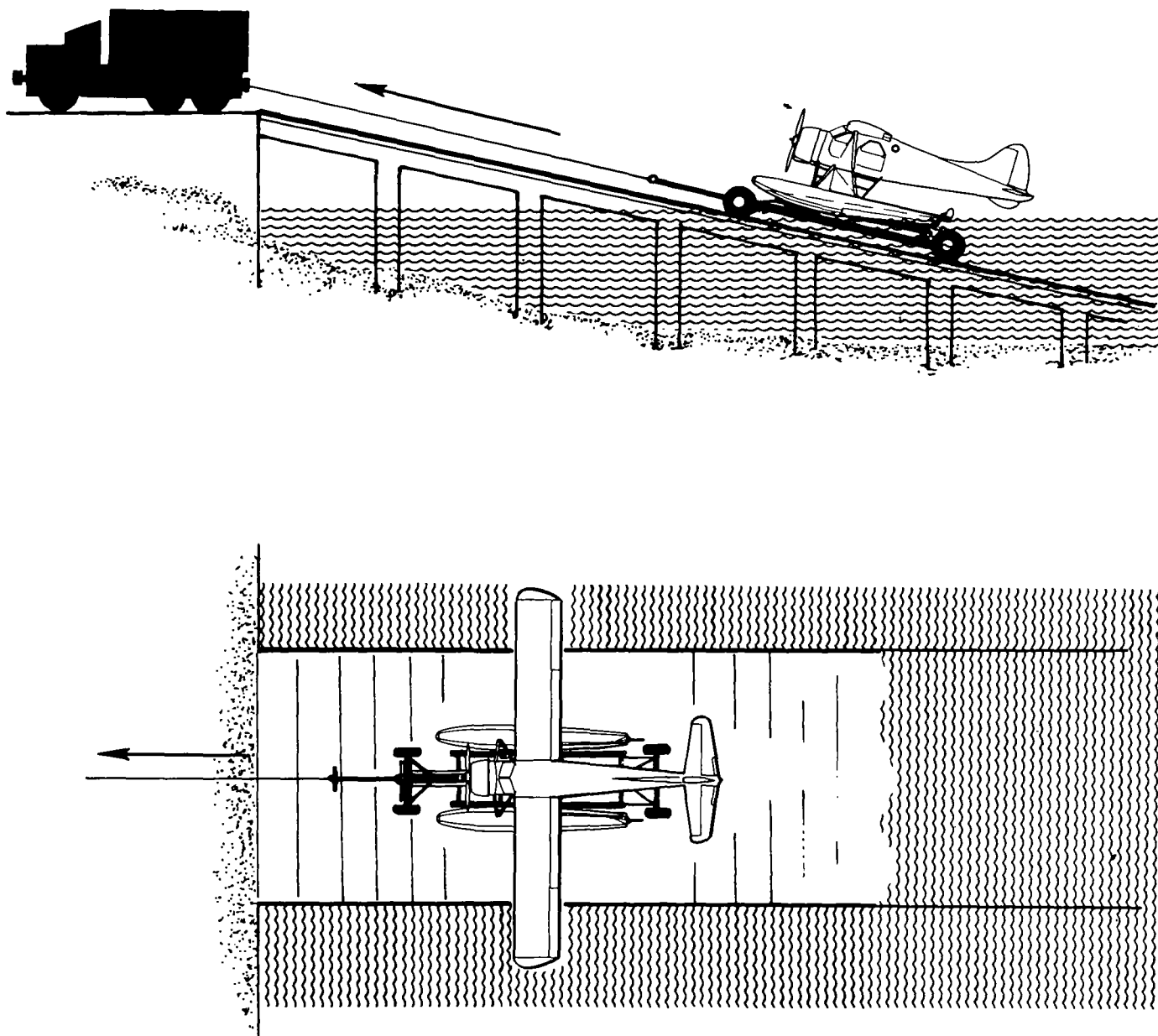
d. Two-wheel dollies are sometimes used for smaller floatplanes in place of the beaching gear. The dolly is inserted on shore by rocking the plane up on the curved forward portion of the keels, lifting on the aft ends of the floats, while the dolly is being placed under the steps. For larger planes, a four-wheel dolly may be rolled down a ramp and into the water to receive the plane, then winched back up the ramp. One type of dolly is placed between the floats and the floatplane is picked up by the float spreader bars (fig 20).¹ In wind conditions, it is a definite advantage to run the floatplane up on the ramp so that the plane will not be blowing about in the wind.

¹ Idea contributed by Edo Commercial Corporation, 65 Marcus Drive, Melville, New York 11746.

92. Salvage After Capsizing

When capsizing occurs, the major damage usually results from the salvage operation. Use of a floating crane is the best method of recovery. All float cover plates should be removed and the plane hoisted very slowly as the water drains from compartments. Lack-

ing a crane, the floatplane can sometimes be maneuvered to a position on its nose by flooding the bow compartments, then pulled upright by lines attached to the bow cleats and tail. After the floatplane has been towed into shallow water, partial disassembly under water may be possible.



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Figure 20. Dolly on ramp picking up floatplane by float spreader bars.

CHAPTER 9

SKIPLANES

Section I. SPECIAL PILOT TECHNIQUES FOR 'SKIPLANES

93. Equipment and Techniques

If possible before flight, the pilot should ascertain ice thickness and snow cover at destination. Should a forced landing become necessary or should the ski-plane become unserviceable at a remote location, suitable crew clothing should be worn for survival under cold conditions. Under arctic conditions, mittens are preferred to gloves. Also, sunglasses and a knife should be carried.

a. Aircraft Equipment.

(1) When returning to base the same day.

- (a)* An extra quart of hydraulic fluid.
- (b)* A 50-foot length of rope.
- (c)* A shovel.
- (d)* An ice pick or ice drill.
- (e)* A long-handled broom.
- (f)* Six red or solid colored flags for marking

landing area and/or holes.

- (g)* Containers of engine oil.
- (h)* Emergency rations.

(2) For overnight stay on lake before return to base. In addition to the equipment in (1) above, the following should be carried:

- (a)* Wing covers.
- (b)* An engine cover.
- (c)* Tiedown ropes or kit.
- (d)* A catalytic heater, plus fluid and alcohol.
- (e)* One 5-gallon container of deice fluid, with spray nozzle.
- (f)* Four lengths of wood board—3 feet 6 inches by 2 inches by 4 inches.
- (g)* Wrenches and pliers to remove battery if necessary.
- (h)* Lightweight portable aluminum ladder (if available).

Note: Equipment is easily lost in the snow. To prevent this, each piece should be painted red.

b. Special Techniques. Ski equipment is designed to permit an airplane to operate from snow or ice surfaces. Since the consistency of frozen surfaces varies widely, and no one type ski can be designed to meet all conditions, modern ski designs are a compromise. For example, to achieve maximum support, a

long, wide surface is needed for light, powdery, new-fallen snow; however, a sharp, thin blade is needed for directional control on smooth, hard ice. Wet, crusted, slushy, or drifted snow adds to design requirements. Also, changeable weather or cross-country flights require equipment able to cope with runways free of ice and snow. As far as possible, all requirements are met in modern aircraft skis. Skis in current Army use are retractable to permit use of the standard landing-gear wheels. Ski bottoms are covered with a plastic sheathing to minimize sticking and prevent freezedown.

(1) Ground handling. The pilot should realize both the limitations and advantages of his particular ski equipment. Compared to the standard wheel-equipped airplane that incorporates individual brakes for steering, skis are clumsy and unmaneuverable while on the ground. Like a floatplane, a ski-plane has a tendency to weathercock with the wind and needs considerable space in which to maneuver. The care, method of parking, and general maneuvering on the ground require a special technique which a pilot acquires only through practice.

(2) Flight characteristics. In the air, skiplane flight characteristics are similar to the flight characteristics of airplanes with standard landing gear, except for a slight reduction in cruising speed and range. Leaving the skis in extended DOWN position in flight produces no adverse effect on trim, but may result in a slight loss of speed. The operator's manual should be consulted for skiplane performance data and weight and center of gravity considerations.

c. Procedures Before Skiplane Flight. In addition to the normal preflight inspection, a careful examination should be made of the main and tail skis, the clamping bolts which attach the skis to the fuselage, the limiting cables and bungees, and the accessible components of the retracting mechanism. Failure of limiting cables could permit the skis to rotate to a vertical position and render control in the air uncertain and landing a major problem. The hydraulic retracting mechanism should be checked for fluid supply and leaks. The retracting mechanism should not be routinely cycled (raised and lowered) on the ground.

d. Skiplane Engine Runup.

(1) On snow, engines can usually be run up without skis being chocked, since approximately full power is required to start the skiplane moving. Wait until engine has reached proper operating temperatures, and in particular ensure that the oil is warm enough, before attempting to use large throttle openings. The skiplane may start to move before this point is reached. If so, the acceleration will be slow and ample time will be found to close the throttle the amount necessary to keep the skiplane moving at the desired speed.

(2) On ice, improvised chocks may be necessary or the engine may have to be run up while the plane is tied down in the parking area. Some form of chock or sandbag may be placed under the nose of the skis. Proper operating temperatures may be obtained while taxiing.

e. Skiplane Tendency to Stick in Stationary Position. If the skiplane has not been resting on supports or glare ice or crust, ski bottoms may freeze solidly to the ground and be difficult to free.

(1) Several helpers may be required to push the skiplane in order to start it moving. The helpers should alternately push on opposite sides of the fuselage near the tail section and on a bulkhead identified by a row(s) of vertical rivets. This use of leverage frees one ski at a time. Additional help may also be used to push at other suitable vantage points. Meanwhile, the pilot uses all the power assistance practical. The engine must not be overheated by excessive long-running periods at full power, and the helpers must not overstrain the structure by applying so much force in one direction that it will twist or shear the shock struts or otherwise damage the plane. Lowering the flaps to takeoff position may aid by creating extra lift from propeller thrust.

(2) When assistance is not available, the skis may sometimes be released by working the elevators and rudder while applying power. Under these conditions, care should be taken to prevent a noseover. The pilot should simultaneously—

(a) Rock the controls back and forth with application of right and left rudder.

(b) Apply sufficient throttle to cause the skiplane to break itself loose.

(3) If the above methods should fail, the snow must be dug away from the sliding surfaces of the skis and the surfaces scraped and polished clear of frost and ice particles.

(4) Another method is to pump the skis up and down with the hydraulic retracting mechanism. This method should be reserved for emergencies only, as hydraulic pressure is high in all lines and activating mechanisms, especially during the second half of the cycle.

(5) Once the skiplane moves a short distance, the sliding surfaces automatically become polished and progress will become comparatively easy. Once free, the skiplane should be kept in motion to avoid letting the skis stick fast a second time.

94. U-1A or U-6A Wheel-Ski Operation

The U-1A or U-6A wheel-ski installation permits all normal operations on wheels or skis at the discretion of the pilot. Taxiing directly from snow-covered ground to cleared runways is possible, since the main-wheel skis can be retracted and extended on the ground with or without the skiplane in motion. The wheel brakes can be used to aid ground maneuvering on wheel skis by partially retracting the main-wheel skis so that the main wheels protrude slightly below the level of the running surfaces of the skis. The main-wheel skis are raised and lowered in relation to the main wheels by means of a hydraulic control unit located on the cockpit floor. The hydraulic control unit has a ski hydraulic handpump lever and a ski selector valve knob. Hydraulic pressure retracts and pneumatic pressure extends the main-wheel skis. The wheel-ski hydraulic system is separate from the aircraft hydraulic system. The tailwheel ski is not retractable, and is attached and trimmed so that it will act either as a tailwheel or tail ski (*d* below) without requiring adjustment by the pilot.

a. Ski Hydraulic Handpump Lever. The main-wheel skis are retracted by positioning the ski selector valve knob to UP and pumping with the ski hydraulic handpump lever, using an up-and-down movement. The resulting hydraulic pressure in the wheel-ski hydraulic system extends an actuator on each main-wheel ski, forcing the ski linkage to swivel around the axle attachments and retract the main-wheel skis. Approximately 100 strokes (50 strokes in each direction) are required to retract the main-wheel ski completely.

Note. The main-wheel skis will trim safely in flight at any partially retracted position; therefore, the pumping can be done at the pilot's convenience and in easy stages if desired.

b. Ski Selector Valve Knob. The ski selector valve knob moves in a slotted quadrant, marked SKI, with positions UP and DOWN. To select UP, the ski selector valve knob is moved, against the tension of a spring, to the UP position. It is retained in this position by another spring inside the knob. To select DOWN, the ski selector valve knob must be lifted before it can be moved. The main-wheel skis are retracted as in *a* above. The hydraulic pressure in the system works against a compressed air charge in the upper portion of each ski actuator, creating increasing pneumatic pressure as the main-wheel skis are retracted. The pneumatic pressure supplies power for

the next extension of the main-wheel skis. They are extended by moving the ski selector knob DOWN. This releases the hydraulic pressure and allows the pneumatic pressure in the actuators to return the main-wheel skis to the DOWN position. When the main-wheel skis are down, the compressed air in the actuators cushions the landing impact.

Note. The ski-lowering operation requires only a few seconds for full extension. If an intermediate position is desired, the wheel skis should be fully extended and then partially retracted to the required position.

c. Ski Position Gage. The ski position gage is a hydraulic pressure gage marked SKI POSITION, UP, and DOWN. It is connected to the wheel-ski hydraulic system. Since the hydraulic pressure is directly proportional to the main-wheel ski positions, the gage gives a true indication of the relative positions of the main-wheel skis.

d. Steering Systems.

(1) *U-1A tailwheel power steering.* The tailwheel power steering system facilitates taxiing in strong winds. It can be used with equal advantage when operating on wheels or on combination wheel skis. The circuit is supplied power from the primary bus, and is protected by a push-to-reset circuit breaker, marked TAIL STEER, located on the circuit breaker panel behind the copilot's seat. The system consists of an electric steering unit, a magnetic clutch, and a power steering panel in the flight compartment. In the center of the power steering panel is a three position power steering switch. The switching positions are marked GROUND STEERING, OFF, and TAIL WHEEL LOCK.

(a) When the switch is positioned to GROUND STEERING, an amber light will come on and the tailwheel or tail ski responds to movement of the rudder pedals. For any other position of the power steering switch, the amber light will be off.

To avoid undue wear on the steering mechanism and especially on the tailwheel tire, the power steering switch should be at GROUND STEERING only for taxiing in strong winds.

(b) When the switch is positioned to OFF, the tailwheel is free to castor through 360°, but castoring of the tail ski is limited by the trim cords. The switch should be at OFF for ground handling or when the skiplane is not moving. When the plane is being maneuvered by tail towing equipment, the trim cords should be disconnected from the tail ski to avoid stretching or breaking the cords.

(c) When the switch is positioned to TAIL WHEEL LOCK and the tailwheel is within its operating range, the steering unit immediately centers and locks the tailwheel fork—regardless of the position of the rudder pedals—and a green light comes on. The power steering switch should be at TAIL WHEEL LOCK for takeoff, flight, and landing.

(d) Because of the self-centering feature of the tailwheel fork, it may be locked when taxiing on the ground or while in flight. An overload slip clutch protects the mechanism and skiplane structure from severe side overload. As soon as the loads become normal, the tailwheel fork is automatically recentered.

(2) *U-6A tailwheel steering.* The tailwheel assembly is connected by cable to the rudder pedals, and may be steered to an angle of 25° on each side of the skiplane centerline. The 25° includes 7° free play. Beyond this 50° steering range, the tailwheel automatically disengages from the rudder pedals and becomes fully castoring. Reengagement of the tailwheel steering mechanism is achieved automatically by taxiing straight with the rudder neutral. The steering mechanism is fully engaged when a definite resistance is felt to the operation of both rudder pedals.

Section II. TAXIING

95. Skiplane Maneuvering

Prior to taxiing, the skiplane pilot should make a cockpit check. Taxiing on skis requires more space for maneuvering room since steering is accomplished by use of the slipstream on the rudder and the tailwheel or ski. In addition to the weathercocking force of the wind, the tendency of skis to drift or skid laterally should be considered. If a large amount of power is required to keep the skiplane moving, a complete stop should not be risked since skis tend to stick to snow or ice if not kept moving (para 93e). Maneuvering on snow can often be assisted through partial retraction of the skis as follows:

a. Select UP on the ski selector lever and retract

skis by operating the handpump until the brakes become effective.

b. On firm ground, retract skis fully to avoid accidental damage of the skis by unobserved rough ground.

c. If complete retraction is not desired on cleared runways, taxiing strips, and dispersal aprons, taxi with skis two-thirds retracted.

96. Taxiing Procedures

a. Turning out of the wind in tailwheel-type airplanes can best be accomplished by a generous blast of the slipstream on the rudder, and at the same time pushing the stick hard forward enough to take as much weight off the tail as possible without nosing up.

b. The pilot should keep the forward speed low by intermittent blasts of the slipstream.

c. More or less lateral drifting is normal, particularly while effecting turns. This need not cause alarm unless the groundspeeds are high and there is danger in striking hard drifts, ice hummocks, or partially hidden rocks, etc.

d. Taxiing downwind may be quite tricky, as a wind on either quarter may cause a complete and uncontrollable weathercock into the wind again. If this should happen, the pilot should keep turning and again try to balance the course to be steered to as near a neutral downwind direction as possible.

e. The power required for steering downwind under good sliding conditions is likely to set up excessive groundspeeds and the skiplane may get out of steering control. Eventually it will have to be slowed to turn into the wind for takeoff. Under excessive speed conditions, the weathercocking effect of a strong wind can result in a high-speed ground loop

with severe side drift. If the downwind ski should slice into or strike a hard snowdrift, the skiplane may be severely damaged. Taxi speeds should be just fast enough to prevent sticking of the skis.

f. Crosswind taxiing may result in considerable drift and the skiplane will advance in "crab fashion." This need not be alarming unless the wind is strong, in which case the downwind ski will tend to slice in sideways and submerge. The situation may become precarious and the skiplane rendered vulnerable to being turned completely over by the wind. Good judgment and caution will dictate the proper procedure to follow.

g. Glare-ice conditions may be encountered in certain localities and at certain seasons of the year. Such conditions make steering very difficult, particularly in strong winds. Outside crew assistance should be called up to help guide the skiplane to the position for takeoff, and landing should be arranged so that remaining taxiing to destination is upwind.

Section III. TAKEOFF AND LANDING

97. Effect of Sliding Coefficient of Friction

Since snow surface conditions vary greatly, a varying amount of force is required to overcome the interlocking effect of friction between the skiplane and the snow. Friction always acts opposite to the direction of motion. The force applied to the skiplane at the time motion starts is greater than the force needed to keep it moving with uniform motion. The first force must overcome *limiting friction* and the second force must overcome *sliding friction*. If the force necessary to overcome limiting friction is continued after the skiplane starts to slide, this creates an unbalanced force, and the skiplane has an acceleration. In addition to sliding friction, two other forces act on the moving skiplane. One is gravitational force and the other is the force created by the snow surface over which the skiplane is sliding. The gravitational force is represented by the weight of the skiplane. The force created by the snow surface pushing up on the skiplane acts at right angles to the snow surface on which the skiplane is sliding (*normal force*). The ratio between the sliding friction force and the normal force is the *sliding coefficient of friction* (i.e., Sliding coefficient of friction =

$$\frac{\text{Sliding friction}}{\text{Normal force}}$$

The sliding coefficient of friction for takeoff and landing on snow may vary from 0.02 to 1.2. It has an important effect on skiplane takeoff and landing ground distances. For example—

a. Ground Distance for Takeoff in a U-6 Skiplane.

(1) *Doubtful snow conditions.* Under doubtful snow conditions, expect a sticky snow ground run

(sliding coefficient of friction greater than 0.3). Allow for a ground run of from 2,000 to 3,000 feet.

(2) *Normal snow conditions.* If the sliding friction is known to be normal (sliding coefficient of friction less than 0.3), add 1,000 feet to the landplane takeoff figures to obtain length of ground run.

(3) *Slippery snow or ice.* On very slippery snow or ice (sliding coefficient of friction less than 0.1), add 100 feet to the landplane takeoff figures to obtain length of ground run.

b. *Ground Distance for Landing in a U-6 Skiplane.* Since weather conditions may change rapidly, snow which was sticky on takeoff may prove very slippery on landing.

(1) *Doubtful snow conditions.* Under doubtful snow conditions (sliding coefficient of friction less than 0.1), allow for a ground run in excess of 2,000 feet.

(2) *Favorable conditions.* If landing conditions are favorable (sliding coefficient of friction greater than 0.1), add 400 feet to the ground run values for the landplane.

98. Takeoff

a. General.

(1) When takeoff is into the wind on smooth, hard surfaces, ski takeoffs are similar to those on wheels. The run may be longer according to the load carried and the prevailing sliding conditions. The pilot should allow for plenty of run and use flaps in takeoff position. In general, he should not get the tail high for takeoff. It is generally advisable not to allow the skiplane to come to a full stop when turning into the wind for takeoff. The pilot should keep

the skiplane moving in a wide arc when rounding into the wind.

(2) Crosswind takeoffs are similar to wheel takeoffs when the surface provides a reasonable grip for the skis. On smooth, hard ice the takeoff should be approached with extreme caution since this type surface increases side drift and weathercocking tendencies. Drift correction should be applied with ailerons and rudder exactly as in a wheel takeoff.

(3) If operating from deep snow, broken crust in snow, or other bad sliding conditions (wet snow, new-fallen snow, etc.) where flying speed cannot be approached, several tracks should be prepared along the proposed takeoff course. This may be done by taxiing up and down the entire length of the run several times prior to takeoff. If necessary, a lightly loaded skiplane may be used for making tracks. In extreme cases the takeoff load may have to be lightened and successive takeoff attempts made.

(4) Takeoff technique in all cases requires a tail-low attitude (similar to a soft field takeoff) because (a) the glare of snow or ice decreases visual acuity, (b) undetected drifts or sticky spots may cause a sudden drag on the skis causing noseover, and (c) deep snow might otherwise exert enough drag to prevent takeoff.

b. *U-1/A Takeoff Technique.* Takeoff flap should be used to take the weight off the skis as soon as possible and to use the STOL characteristics of the skiplane. The control column should be held back until the skiplane becomes unstuck, then the pilot releases the control column to neutral or forward of neutral to gain flying speed. This reduces wear and tear on skis and prevents ski tips from digging into snowdrifts. The pilot should avoid takeoffs other than into wind. If a crosswind takeoff is necessary, normal technique is used; i.e., aileron into wind.

99. During Flight

The position of the skis has no significant effect on airspeed, center of gravity position, or flight characteristics. Therefore, they may be left in either the UP or DOWN position as dictated by conditions at the arrival landing field. Skis slightly reduce performance capability because of added weight and drag. The applicable operator's manual should be consulted for performance data when the airplane is equipped with skis.

100. Before Landing

Prior to the approach to land, depending on the forecast conditions of the landing field, the pilot should decide whether to raise or lower the skis. The pilot should select skis as desired and when the action is complete, he should check the ski position visually and on the indicator. The failure of one ski to lower and remain in the DOWN position may not be indi-

cated by a visual check of the ski position indicator or the actual ski position while in flight. Upon landing, a strong tendency of the skiplane to turn in the direction of the inoperative ski will be detected. Normally the skiplane can be controlled in this situation throughout the landing rollout; however, a takeoff should not be attempted until the ski is properly extended. In deep soft snow with the skiplane stopped, it may be hard to detect a ski lowering malfunction. By looking back on the landing track, a deep furrow caused by the wheel plowing through the snow on the malfunction side will identify the failure. In an emergency situation where the skiplane must depart from its present position, the main gearwheel may be removed from the inoperative ski and the skiplane safely flown to another landing site. However, it must be landed on a snow or ice covered surface. The pilot must also ensure that—

a. Snow does not deceptively cover uneven ground.

b. Ice is thick enough to support the skiplane (para 20).

101. Landing

a. General.

(1) When surface and visibility conditions are favorable, a standard three-point landing should be made. A tail-down or three-point landing attitude should be attained on the final stage of the approach to reduce the landing run and, when skis are extended, to ensure that raised lumps of snow or ice do not foul the ski tips on touchdown. The landing run may be short or long depending upon the condition of the surface, wind, and landing speed. In deep snow, the pilot should use power and back stick if loss of forward motions is abrupt. When possible, landings on hard ice should be directly into the wind. Plenty of space should be allowed for landing and taxiing on ice.

(2) Since changes in the weather can alter the character of the landing surface in a short time, all landings should be preceded by a thorough high and low reconnaissance. It is advisable to make a reconnaissance from a very low altitude several times to make reasonably sure the landing area is safe and that the surface is satisfactorily smooth and free from hard-packed drifts or ridges caused by the wind. The best landing area should be selected. Generally, this area will be found in the lee of an island or shoreline sheltered from the prevailing wind.

(3) Dangerous light conditions are often encountered where no shadows are cast. The reflected light from snow makes depth perception difficult; therefore, a pilot cannot accurately judge the last few remaining feet of height. Under these circumstances, he should proceed as for a glassy-water landing and use a power approach with a slow rate of descent until contact with the snow is made in the landing

attitude. The pilot should take advantage of sighting along a series of objects or snow formations of definite shape.

Warning: Avoid heading out far from the shoreline of large frozen lakes or rivers.

b. U-1A Landing Technique.

(1) *Approaching a lake or remote snow strip landing area.*

(a) Select skis DOWN.

(b) Watch for smoke, flags, etc., to indicate wind direction.

(c) Fly 300 to 500 feet above ground level over the landing area in landing direction, checking the area for the following obstructions to landing: drifts, blow holes, large cracks, large channel markers, ridges, slush areas, etc. Avoid areas that show rivers or creeks joining.

(d) Select 2,000 rpm, set flaps at climb, and fly over the landing area in landing direction. Set gyrosyn compass pointer in chosen landing direction and make a pass at 50 feet above ground level for a closer look at the landing surface. Should whiteout landing technique ((3) below) become necessary, choose long or wide part of a lake.

(e) If satisfied with landing area, fly over and beyond the landing area (overshoot) and come around again for touch and run (100 yards at not less than 40 knots)—overshoot.

(f) Come around again and (50 feet above ground level) check your landing run ski marks for slush—overshoot.

(g) Complete another circuit and with the skiplane set up for landing, approach the landing area using takeoff or land flap setting. After landing, keep the skiplane moving while doing a post landing check—keep power steering switch at GROUND STEERING. Turn to right 240° to come across landing run—check again for slush in tracks. Complete a figure eight. Stop in ski tracks. Have crewman check ice thickness. Use ski tracks for additional takeoffs and landings.

(2) *Short lake landing technique.* Approach with full flap, maintaining 60-knot instrument airspeed with throttle. Once over the edge of the lake just above the shore or tree line, adjust throttle and skiplane attitude to maintain 60-knot airspeed. Gently flare out and land in three-point attitude. If there is no sun or shadow for depth perception, the short lake landing should be done with caution or not at all.

(3) *Whiteout landing techniques.* Whiteout landings are performed using climb flap, 60-knot instrument airspeed, and 150- to 200-foot-per-minute rate of descent. Experience in whiteout landing will indicate the presence of a buffer zone or cushion 10 to 20 feet above the ice surface.

(a) Once contact is made with the surface, close throttle and bring the control column slowly to the full back position. If the skiplane bounces after initial contact, avoid releasing the control column to neutral or forward since this release may accentuate the bounce.

(b) Make reference to the artificial horizon, heading pointer, vertical speed indicator, and airspeed indicator to keep the wings level and the skiplane from yawing.

(4) *Landings in open snow-covered fields.* The direction for landing may be limited because of the size of the area and obstructions on it.

(a) During the reconnaissance before landing, take special care to observe if deep snow covers all or part of a fence.

(b) Use 60-knot airspeed and 200-foot-per-minute rate of descent. Use the stick to control airspeed and the throttle to control rate of descent.

(5) *Partial raising of skis.*

(a) For very short roll landings, raise the skis full up and use land flap.

(b) To obtain some assistance in turning in confined areas or in shallow snow on an ice or land surface, partially raise the skis so that wheel braking can be achieved.

Section IV. PARKING

102. Maneuvering Space

If possible, final approach to the parking area should be upwind with sufficient maneuvering space available for steering. Whenever possible, skiplanes should be parked headed toward a clear area with sufficient space for safe movement when power is applied.

103. Parking Outside in Subfreezing Temperatures

Unless separated by blocking or insulating materials, a skiplane not equipped with plastic ski bottoms will freeze to the surface in subfreezing weather. Two-by-

fours, pine boughs, plywood sheets, burlap sacks, or almost any nonmetallic material can be used to prevent such freezeups. These materials should be selected with care to avoid nails or other sharp objects which would damage ski bottoms. The material should be spread for the plane to be taxied up on it. Materials such as two-by-fours or saplings should be placed crosswise to the ski. If these materials are not available, a pair of tunnels should be dug under the skis and the supporting stringers inserted after the plane is parked. When these are in position, the remaining snow is dug away until the weight settles on

the stringers. If a solid surface is under the wheels, the skis may be retracted with the hydraulic pump. If the tires freeze to the ground, the skis should be lowered to free them.

104. Preflight Checks

a. When the skiplane has been parked with the skis UP, the running surfaces of the skis should be checked to see that they are free of ice that may have formed by the refreezing of melted snow or slush

sprayed up while taxiing on wheels. Heavy frost conditions will sometimes encrust the running surfaces of the skis.

b. If the main ski running surfaces are left unclean, a subsequent landing may result in an abrupt stop or, if only one ski is encrusted, a ground loop. The extension of the actuators should be visually checked in accordance with the appropriate operator's manual.

Section V. SKI MAINTENANCE

105. General

Current types of skis present few maintenance problems to personnel familiar with basic aircraft structures and systems. Suggestions applicable to ski types now in use are given in paragraph 106 below. The manufacturer's instructions and recommendations should be consulted for details regarding specific models.

106. Maintenance Tips

a. The plastic sheathing on ski bottoms is subject to punctures from sharp objects (including ice) and also may shatter in extremely cold temperatures. Sheathing may be bonded or otherwise secured to the skis by rivets and screws. Replacing the bonded type sheathing is usually impossible in the field. In the mechanically fastened type, substitution of machine screws for the original rivets will expedite all current and future replacements. Screw holes in the sheathing should provide for expansion and contraction. When damage to the sheathing is limited, the manufacturer's recommendations for patching should be consulted. Where damage is extensive, a

new covering may be required for the entire ski bottom.

b. Shock cord bungees used in ski rigging deteriorate rapidly when left under tension. When the skiplane is parked overnight or longer, bungees should be detached at the lower fitting and allowed to hang free. Reattaching the bungees will normally require two or more men.

c. Hydraulic ski-retracting mechanisms are conventional in design and present no special problem. The small, abrupt change of ski attitude occurring at touchdown imposes a severe load on the external hydraulic lines leading to the skis, and these lines are a more prevalent source of trouble than the internal parts.

d. Lubrication of friction points requires the use of low-temperature oils and greases. For lubrication requirements, see the appropriate -20 aircraft organizational maintenance manual.

e. The condition of the limiting cables and their fastenings is important to safety in flight; no fraying, kinking, rusting, or other defective conditions should be tolerated.

CHAPTER 10

FLOAT-EQUIPPED HELICOPTERS

Section I. BASIC RULES AND PRINCIPLES

107. General

Although helicopters fitted with float landing gear may operate over land or water, they are seldom used exclusively for continuous operations from water surfaces. Normally, floats are installed to comply with safety regulations that specify minimum floatation capabilities when a heavy percentage of flight time is flown operating over water. When cleared land is unavailable at an intended landing point or when a forced landing must be made floats provide an alternative to a ground landing where water surfaces are available. The float helicopter has operating advantages in swamps, tundra, snow, and similar areas of soft surfaces. The disadvantages are in the slightly reduced flight performance (para 108) and difficulty in ground-handling after engine shutdown.

a. Float Installation. A typical float installation may consist of two inflatable floats with fittings and attaching parts. For example, some floats are held in position by cross- and float-support tube assemblies. These floats are cylindrical bags of rubberized (or neoprene-coated nylon) fabric that are divided into individual compartments separated by bulkheads. Separate air valves located on top of the bags are provided for inflating each compartment.

b. Paddle Installation. Although not included in the float kit, some type of paddle must be provided for every float-equipped helicopter. The paddle must be securely fastened to prevent it from blowing into the rotor system; however, it must also be readily available to the pilot in case of emergency.

c. Emergency Equipment. During extended operations over open water, the following equipment should be carried in the float helicopter:

- (1) An approved type life preserver for each occupant.
- (2) A lightweight anchor attached to at least 50 feet of line.
- (3) A whistle or horn of the type carried on small powerboats.
- (4) Lights required by FAA Regulation 91.73.
- (5) Overwater survival gear required by Army Regulation 95-1 (sufficient lifevests, liferafts, and appropriate emergency survival equipment for each person on board).

108. Operating Characteristics of Float Helicopters

a. Except for an additional weight penalty and the slight additional drag of the floats, flight performance of the float-equipped helicopter is almost identical to standard landing gear flight performance. Normal airwork can be performed satisfactorily with the float-equipped helicopter. Unless extra power is applied, cruise speed is reduced approximately 5 knots by the drag of the floats. This reduces the range slightly and the additional weight decreases the payload. Maximum forward speed (red line) is reduced approximately 10 percent. For details covering specific helicopter float installations, see the appropriate operator's manual.

b. The float-equipped helicopter is slightly more sensitive to pedal correction. Improper pedal control results in a roll toward the *outside* of a skidding turn, which is caused by the aerodynamic drag forces on the lateral surfaces of the floats. For this same reason, if tail rotor failure occurs, autorotation must be entered immediately to prevent a yawing action which produces an uncontrollable roll unless torque is quickly reduced.

c. Running takeoffs and running landings on land surfaces are not practical with float-equipped helicopters.

109. Preflight Inspection

During the preflight inspection, all specified inspection procedures applicable to the particular helicopter are performed. Floats should be examined for cuts, abrasions, and other indications of damage. Each float compartment should be checked for approximately equal pressure by pressing with the hand. Float pressures should be adjusted before takeoff so that the maximum pressures are not exceeded during flight.

a. Inflation Check. Floats are inflated with clean, dry air to the desired pressure. For correct inflation pressures, see the appropriate operator's manual. Inflation pressures are governed by the basic laws of a perfect gas. Float pressure decreases as temperature decreases and increases with altitude. For high altitude operation, float pressure should be adjusted be-

fore takeoff so that the maximum pressure is not exceeded during flight. When route of flight requires extremely high altitudes, landing to a hard surface may be required to inflate floats prior to landing on water.

b. Valve Check. Compartment air valves should be checked for proper closure and leaks, and the protective flap over each air valve should be secured. All attaching fittings should be inspected for security. When the helicopter has been operating in salt water, a careful check for corrosion should be made. To check for leaks before landing on water, the helicopter should be landed on a hard surface at the same altitude that the water landing is to be made.

c. Horizontal Stabilizer Check. The horizontal stabilizer should be checked for attachment security.

d. Tailboom Check. If a float helicopter is moored in the water, preflight inspection may be conveniently performed by sufficiently loosening the mooring lines to permit swinging the tailboom over or alongside the dock or shore.

e. Floats Used During Cold Weather Operation. During the preflight inspection, the bottom surfaces of the floats should be checked to be sure that they are not frozen to the ground or water surface. The pilot should avoid takeoff under these conditions. If only one float breaks free during liftoff, attempted takeoff with a float frozen to the surface could result in damage to the float and in unusual or uncontrollable attitudes.

110. Hovering and Taxiing

a. Starting and Engaging Rotors. Starting the float helicopter on a hard surface is identical to the starting procedure of the conventional helicopter. Starting on water, however, presents the problem of little or no antitorque control until the rotor system has accelerated to approximately 50 percent of its normal operating rpm. Lack of antitorque control will tend to spin the lightly loaded helicopter during starting and runup. Heavily loaded helicopter floats have greater draft than lightly loaded helicopter floats. Consequently, less torquing effect occurs during starting with heavy loads, thus reducing the turning of the helicopter. Effective directional control rpm will be achieved at a lower rpm for a lightly loaded helicopter than for a heavier loaded helicopter. To overcome spinning and to prevent drifting and turning before sufficient rpm is established, the helicopter should be securely tied at two points, preferably the fore and aft cross tubes, and drawn snugly against the dock or shore. The lines can then be cast off and the helicopter taxied out for takeoff. When a ground guide is unavailable for casting off it may be necessary for the pilot and crew to paddle to a clear location well away from the shoreline to assure a safe start. Wind and/or water currents may cause

the helicopter to turn 360° or more and drift a considerable distance before adequate control is obtained. To compensate for drift, a starting position may be selected near the upwind or upcurrent portion of a small lake or large river. To assure that there is no uncontrolled drift or wander, cockpit and runup checks should be carried out when the helicopter is at a very slow taxi. The illusion of movement or non-movement described in hovering flight (*c* below), also applies when the rotor is engaged and the pilot attempts to maintain a fixed position on the water.

b. Taxiing. Float helicopters should not be taxied on land. On water, the float helicopter may be moved forward, sideward, or rearward, or pivoted 360° over a spot. While taxiing, the pilot must maintain normal operating rpm (green arc) range. Sufficient collective pitch should be applied to provide responsive cyclic control to start the helicopter moving forward. Maneuvering the helicopter on water is limited only by speed. Float-equipped helicopters should be taxied with the nose in the direction of movement. Maximum taxi speed is attained when the bow wave around the nose of the floats rises slightly above the normal waterline. Beyond this speed, the bow wave flows over the front portion of the floats and this severe drag may capsize the helicopter. The heavier loaded helicopter will be restricted to a slower taxiing speed.

(1) Movement of the helicopter is easy to judge when near the bank or an object in the water but becomes more difficult with increasing distance from a reference point. When reference points are unavailable, movement may be judged by swirls, burbles, or slicks around the floats. The pilot must be careful to avoid bottoming collective pitch while the helicopter is in motion to avoid momentarily sinking the floats or capsizing the helicopter.

(2) Float helicopters can be taxied in water having a slight wave action, but under such conditions the floats must be kept pointed across or slightly angled into the waves and not allowed to roll in the trough. In some cases, with application of considerable collective pitch and power, the resultant downwash will have a slight smoothing effect on wind-produced waves. This applies when either taxiing or hovering.

(3) A ground swell can be dangerous to the tail rotor while the helicopter is riding up and pitching over the swell. Collective pitch should be applied to minimize bobbing of the helicopter.

c. Hovering Flight. When hovering near the shore or some object in the water, helicopter movement is readily discernible by reference to the shore or the nearby object. Under certain conditions, sensations of hovering a helicopter over open water can be deceptive. On open water without close reference points, extensive or rapid helicopter movements may go un-

noticed. This condition is aggravated over very smooth or very rough water. A light breeze causing moderate rippling of the surface is the most desirable water condition. An odd sensation, similar to vertigo, is sometimes produced by the concentric outward ripples resulting from the rotorwash, and the pilot must keep his eyes moving and avoid staring at any particular spot. The inexperienced pilot may choose to initiate a slight forward movement when taking off to or landing from a hover. This will guard against undesirable backward or sideward drift during takeoff or landing. With smooth water conditions, the usual tendency is to hover too high. This is caused by the outward-flowing ripples from the rotorwash, which give the pilot the sensation of descending. He will normally respond by applying collective pitch to halt this apparent movement and may eventually realize he is hovering at a 10- to 15-foot altitude. High hover speeds should be avoided to prevent capsizing the helicopter during emergency hovering autorotations.

111. Takeoff and Landing

a. Takeoff. Normal takeoffs with floats can be accomplished from the water or from a hover. If this is impossible, takeoff can be accomplished from a taxi.

(1) *Water takeoff.* A takeoff directly from the water is preferable; i.e., moving forward into translational lift without pausing to hover. This technique is comparable to takeoff from a confined area except that no barriers are present.

(2) *Hover takeoff.* Takeoff from a hover should be performed in the usual manner. The major problem is in judging altitude and rate of acceleration. The usual tendency is to accelerate too rapidly, causing an "airspeed-over-altitude" type takeoff. During takeoff, restricted visibility is encountered due to water spray that is produced by the rotors.

(3) *Takeoff from a forward taxi.* Although some translational lift is available at slower speeds, this lift is not very effective due to tucking under of the floats (para 110b) as speed is increased. Sufficient collective pitch should be applied to keep the floats riding high or skimming the surface. (Maximum forward airspeed that can be attained without tucking of the nose will be determined by the load and attitude of the helicopter.) While skimming the surface, float drag increases rapidly, and the takeoff must be executed promptly since a further increase in speed is likely to exceed the limit of aft cyclic control. No attempt should be made to lower collective pitch; this would bury the nose of the floats.

b. Landings.

(1) *Landing on a hard surface.* All float landings on a hard surface must be at zero groundspeed. Any movement on the ground surface will tend to scuff the floats and can cause considerable damage.

Approach is made in the normal manner, terminating at a hover. Vertical descent is made from the hover, placing the collective pitch smoothly to the full down position after positive ground contact is made. If hovering is critical, making an approach to the ground more desirable, the approach is continued through hovering altitude in a slightly nose-high attitude. Just as the aft portion of the floats touch, sufficient collective pitch is added to halt the descent and prevent forward motion. The cyclic is rotated forward until contact is established, with collective pitch reduced to the full down position.

(2) *Landing on water.*

(a) *Water with a slight chop.* When landing on water with a slight chop, the same general technique applies to this landing as that for a hard surface in (1) above.

(b) *Water with a glassy surface.* If the water is smooth, especially with a glassy appearance, some difficulty will be experienced in determining altitude above the surface. In such case, the approach should be continued with a slow rate of descent until contact is made, avoiding any attempt to approach to a hover. If the rate of descent and forward speed are slow, some disturbance of the water surface will occur as ground effect builds up. The disturbance will appear as concentric ripples moving away from the helicopter and it may cause the pilot to have a sensation of moving backward or descending rapidly. A natural tendency will be to apply too much collective pitch. At this point, some forward and downward movement should be maintained until water contact is made. To aid in depth perception and to maintain proper perspective, the pilot should avoid staring at the water near the helicopter. When making approaches to a landing on a large body of water when land areas or other fixed objects are not visible, the pilot should occasionally glance to either side of the horizon to avoid stare-fixation during his approach.

(c) *Landing with a forward airspeed.* This type of landing should be used only if insufficient power is available to land at speeds of less than 5 knots. Such an occasion would be when landing with high density altitude and a heavy load, or when partial power loss during or just after takeoff makes it impossible to maintain altitude. If more than a 5-knot forward speed is required for touchdown, a slight nose-high attitude is held to allow the aft portion of the floats to plane. The helicopter is kept light with collective pitch until speed has decreased to less than 5 knots. At this point the nose should be lower and collective pitch is gradually reduced to the full down position after the helicopter has come to a complete stop.

(d) *Water with a rough surface.* Landing the float helicopter on water can become critical when the waves are short and choppy and exceed half a

meter from trough to crest. These waves will cause the helicopter to pitch rapidly and may bring the rotor blades in contact with the tail boom. When the waves are the long swell type with considerable distance from crest to crest and without sharply defined ridges, it is possible to land the float helicopter in seas as high as 3 meters. If landings are to be made on waves higher than half a meter, the following techniques apply:

1. The helicopter should not be landed directly into the waves; instead, the heading should be 30° to 45° off to one side. This will minimize the fore and aft pitching of the fuselage and reduce the possibility of the main rotor striking the tail boom and the tail rotor making contact with the water.

2. After a water landing with power, rotor rpm should be maintained in the normal operating range. This will permit quick takeoff if the helicopter begins to pitch excessively or upon the approach of an especially high wave.

3. After a power-off landing has been made under high wave conditions, the desired heading should be held as long as directional control permits. As the rotor rpm decreases to the point that the desired heading cannot be maintained, the rotor should be brought to a stop as quickly as possible.

112. Autorotation

- a. On Land.* Autorotative touchdown on land with the float-equipped helicopter requires essentially the same technique as a regular zero ground roll autorotation with conventional skids. Although autorotational landings on a hard surface are possible the maneuver should be limited only to actual forced landings because of the excessive wear on the floats. When conditions make autorotative touchdown a critical planning factor, flight paths should be planned within reach of suitable water areas where a forced landing can be made with safety.

- b. On Water.* Autorotative touchdown on water with forward speed is possible; although, for greater safety, sufficient deceleration should be accomplished to reduce forward speed to approximately 5 knots. Some difficulty with depth perception may be experienced on smooth, glassy water (para 111b(2)(b)). Landings should be planned near a shoreline or some object in the water. This will aid greatly in judging altitude just prior to touchdown. Touchdown should be made with a slight nose-high attitude, allowing the rear portion of the floats to plane in. Collective pitch should be applied to stop the rate of descent and to reduce the forward speed below 5 knots. Then the remainder of the pitch can be used to cushion the helicopter into the water. Collective pitch is placed in the full down position after the helicopter is riding level in the water with slow forward speed. Dur-

ing the deceleration and nose-high landing, the tail rotor must not be allowed to dip into the water.

- c. Antitorque Failure.* Although most antitorque rotor type helicopters can continue to fly after an antitorque control failure, this is not true of the float-equipped helicopter. If power is not reduced immediately after antitorque failure, the float-equipped helicopter will enter an uncontrollable roll, caused by the large amount of aerodynamic drag on the lateral surfaces of the floats. If an antitorque failure occurs, autorotation must be entered *immediately*. The autorotative landing should be made directly into the wind or with the wind slightly from the right. Upon touchdown, the helicopter should have zero forward airspeed. The tendency of the helicopter to yaw to the right when applying collective pitch will be overcome by the drag of the floats upon contact with the water.

Warning: If there is any possibility that the tail rotor struck the water during water operation, no attempt should be made to take off. Although a tail rotor water strike may not show any visible evidence of damage, this makes tail rotor failure likely to occur.

113. Mooring and Ground Handling

- a. Shutdown and Mooring.* Many docks used for boats have posts extending several feet above the main dock level, and the pilot must be certain that blade droop, caused by reduced rpm, will not cause the blades to strike any object on the dock. If near the ocean, tides must be considered. The water level may change sufficiently within a few hours to tilt or lower the helicopter enough to cause damage. If this is anticipated, mooring lines should be loosened and arranged to prevent the tail from swinging into an object after the rotors have stopped. Some pilots prefer to moor the helicopter nosed in toward the dock to protect the tail rotor. Although the helicopter can be moored if necessary, it is preferable to hover up on the dock or shore to park. If room is available to allow for drift and possible turning or weathercocking until the rotors have stopped, the helicopter may be shut down on the open water. Pedal control is effective after engine shutdown, even at relatively low rpm; but wind and water currents may move the helicopter quite a distance. If the pilot intends to moor at a buoy or dock, the shutdown should be performed upwind or upcurrent and the helicopter allowed to drift in. In this manner, the pilot can shutdown and moor the helicopter by properly positioning the helicopter and using a paddle.

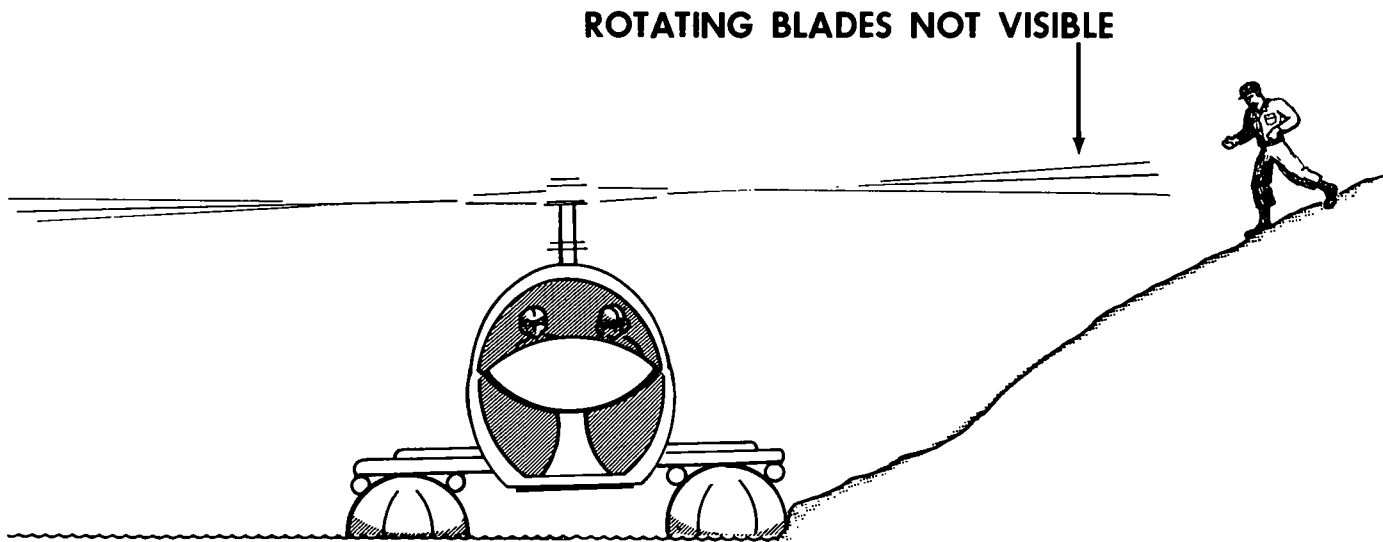
Warning: Because of the great danger from the main rotor or tail rotor of the helicopter to personnel or docks or vessels, pilots should never

attempt to taxi up to a dock or to approach a vessel. Also, loading or unloading passengers or freight from a partially afloat helicopter with rotors turning is extremely dangerous (fig 21).

b. Loading and Unloading Passengers From Float Helicopters. Although helicopters are normally equipped with floats as a safety measure for operations *over* water (para 107), they are seldom used to operate from the surface of the water. Passenger loading and unloading procedures are conducted with

the helicopter resting on a hard surface on shore or on a helipad on a dock or on a boat. Helipad dimensions must be large enough not to allow any water overhang of main or tail rotor tip-path plane.

c. Ground Handling. Ground handling the float-equipped helicopter is difficult without a special dolly or wheeled platform. If a manufactured ground-handling dolly is unavailable, local manufacture is usually possible. When handling a float helicopter on a dolly, avoid bumping rotor blades and fast towing over a rough surface.



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Figure 21. Danger to an individual approaching a helicopter.

Section II. HELICOPTER PNEUMATIC FLOAT MAINTENANCE

114. General

Helicopter pneumatic floats require a minimum of maintenance and often remain in operation for several years with only routine attention. After extended use, they may become porous and require more frequent pressure checks. For specific maintenance procedures, see the appropriate -20 aircraft organizational maintenance manual. If instructions are unavailable, the procedures in paragraphs 115 through 120 below may be used.

115. Postflight Inspection

A postflight inspection is performed as follows:

- a. Check each float compartment (section) for proper inflation.
- b. Inspect the entire float assembly for cuts, tears, condition of chafing strips, and security of attachment of all components, including the paddle.
- c. Wash oil, grease, or gasoline from the floats, since they will deteriorate the rubber.
- d. If the helicopter has operated from salt water, flush the entire helicopter including the float assembly with plenty of fresh water.

116. Periodic Inspection

This inspection will include all procedures applicable to the helicopter equipped with the conventional landing gear. In addition, the floats should be thoroughly inspected for signs of cracking or checking and, when necessary, neoprene preserver (para 118) or rubber cement should be applied.

117. Porosity Control

Porosity may be controlled by painting a porous section or an entire float with rubber cement as follows:

a. Preparation.

- (1) Wash the area to be painted with a good grade of nonalkaline soap and warm water.
- (2) Allow to dry.
- (3) Brush thoroughly with a clean brush to remove imbedded particles—dust, sand, etc.
- (4) Rewash three times with a cloth saturated with toluene. Use clean lint-free cloth for each washing.
- (5) Allow to dry **THOROUGHLY** for a minimum of 20 minutes.

b. Painting.

(1) Add self-curing adhesive MIL-A-5540, class 5, to the accelerator following manufacturer's directions.

(2) Mix solution thoroughly.

(3) Apply two brush coats, allowing one-half hour drying time between coats.

(4) Allow second coat to dry for one-half hour.

(5) Open air valve to section being repaired and allow air to escape until just enough remains to maintain the shape of the float. If more than one section is to be painted, block up the helicopter before deflating.

(6) After deflation of the section(s), apply two additional coats of sealing solution, allowing one-half hour drying time between coats.

(7) Let dry at least 12 hours before reinflating.

Note. The sealer-cement must be used within 90 days of the date on the can and is usable for not more than 8 hours after mixing.

c. Replacing Chafing Strips.

(1) If bottom chafing strips are badly worn or torn, cut old strip from float.

(2) Cement a 2-inch strip down each side and through the center only. Do not cement entire surface of strip. Also, do *not* cement new strip *over* old.

(3) Proceed as for applying patch (para 119).

118. Neoprene Preserver Application

The service life of the floats may be extended by applying a coat of neoprene preserver every 30 to 60 days as follows:

a. Clean float surfaces thoroughly as in paragraph 117*a*.

b. Use adhesive MIL-A-5540, class 3, following manufacturer's directions.

c. Apply mixture with brush or spray at room temperature of 72° F. or above. Allow 12 hours drying time.

d. Apply a finish coat if desired. (Red, yellow, or black pigmented cement may be procured by specifying the desired color of adhesive MIL-A-5540,

class 3, as listed on the Parts List. The required drying time is 12 hours.)

119. Permanent Puncture or Tear Repair

Permanent repairs of holes or tears in floats are made as follows:

a. Deflate the float bag to be repaired.

b. If the hole is very small, trim to one-half inch in diameter to provide access for cleaning and cementing inside surface of float.

c. Prepare patch of same material as float. The patch should be large enough to overlap the hole or the tear by 2 inches. Buff or roughen surface of patch. Wash roughened surface of patch and inside of float (2 inches around tear or puncture) with toluene.

Caution: Use cleaning agent carefully, as too liberal application will swell the rubber with which fabric is impregnated.

d. Apply three coats of air-drying rubber cement to patch and to cleaned area inside float. Allow 15 minutes drying time between coats.

e. When both surfaces are dry but still tacky, insert patch through opening. Flatten a portion of the float and carefully lay patch down, cemented side up directly under injury. Center damaged portion over patch and press downward onto patch. If damage is a tear, bring edges together so as to dovetail any irregularities. Smooth fabric over patch with a roller.

f. Prepare a second patch of lighter weight fabric (same type material as float), allowing patch to overlap 1 inch. Accomplish steps *c*, *d*, and *e* above on external patch.

120. Temporary Repair of Floats

Temporary field repairs of small punctures in float bags can be accomplished by applying external patches. A 2- or 3-inch overlap should be allowed and applied as in paragraph 119. Such temporary repair should be replaced by permanent repair at the earliest opportunity.

CHAPTER 11

SKI-EQUIPPED HELICOPTERS

121. General

a. Landing or Takeoff in Snow. Snow depth is not a limiting factor for landing or takeoff in helicopters equipped with skis. In open areas, snow may be wind compacted and blow very little in ground operations. In confined areas or in hilly terrain, snow may be loose and may cause severe visibility problems when landing or taking off. When landing in formation in the snow, a minimum 50-meter separation may be satisfactory or stagger landing at normal distances but with a 15- to 30-second time lag. When landing in powdery snow conditions, helicopters may have to be spaced at 50 to 100 meters apart because of blowing snow and loss of visibility near the ground.

b. Landing in Muskeg and Tundra. Skis are also very useful for landing in muskeg and tundra during the summer in the Arctic and subarctic regions. They provide a larger surface for the helicopter, thus assisting in its stability when landing on uneven and soft spongy surfaces. Care must be taken on lift-off that the skis are not hooked under hummocks or brush.

c. Individuals Approaching Helicopters on Ice. To prevent the possibility of main rotor blades striking individuals if one landing gear drops through the ice, individuals must approach tandem rotor helicopters directly from the front or rear. All others should be approached from the front.

122. Preflight Inspection of Ski Installation

The pilot should—

a. Check all the steel bands and bolts securing skis to skids for security and after movement along the skids.

b. See that a rubber liner is between each steel band and the skid.

c. Inspect steel runners on the bottom of skis.

d. Inspect skis on edges for separation of fiber layers.

123. Hovering and Taxiing on Snow and Ice

To effect a reduction in blowing snow caused by rotor wash, taxiing on skis is normally favored over hovering.

Caution: Severe disorientation may result from rapid recirculation of snow down through the rotors while hovering, taxiing, or on final approach to land.

a. Hovering. When hovering over snow, the pilot should select a reference point to avoid a whiteout condition. To avoid blowing snow conditions when hovering forward over loose snow, he should hover at a speed just above effective translational lift (about 15 to 20 knots) or at a higher hover.

b. Ground Taxi. The pilot should taxi at slow speed (5 knots or less) and use caution on brake application with wheeled helicopter on ice as the helicopter may skid sideways and render the helicopter uncontrollable. Corrective action is to lower collective pitch and place all the weight of the helicopter on the ground. If this action does not stop the helicopter, the only action left is to bring the helicopter to a hover. This procedure also applies to skid-equipped helicopters.

Caution: The pilot's senses can be severely taxed by phenomena such as blowing snow drifting over the surface of packed snow or ice, giving him the sensation of moving (in some direction) when, in fact, he may be completely stopped or even moving in another direction. When operating in such conditions, fixation can be disastrous; so the pilot must make a great, concentrated effort to avoid distraction.

124. Troop Loading

Troop loads for helicopters used in arctic operations are reduced (e.g., seven troops on UH-1D/H) because of the space required for individual rucksacks, survival gear, and skis or snowshoes. Additional time is required for loading and off-loading this equipment when landing zones are located in deep snow areas. Another limiting factor to be considered is the additional weight of the skis. Table 6 is provided to help determine the mission weight of the ski-equipped helicopter.

Table 6. *Ski Weight Information*

Helicopter	Approximate ski weight (lb)	No. of skis	Approximate total weight (lb)
UH-1D-----	135	2	270
CH-47-----	238	4	952
CH-54-----	163	nose 1	163
	272	main 2	544

125. Takeoff

All helicopters should use normal takeoff procedures in snow, stressing a proportionate increase of airspeed with altitude. As power is applied, instrument conditions will prevail until reaching translational lift. Pilots should be cautious of takeoff in loose, powdery snow, as a whiteout may be encountered. A standard instrument takeoff will be safer under these conditions. Blowing snow problems will lessen as altitude and airspeed increase. Takeoff from ice requires no unusual techniques, except caution should be exercised when increasing or decreasing power to prevent any loss of directional control. A slow application of power and the use of pedals will assist retention of directional control. The skis may freeze to the ice under certain temperature ranges. Caution should be exercised on lift-off, as one ski may be free and the other frozen to the ice. Under these conditions, an alternate light application of left and right pedals will usually free the skis. Excessive application of pedals may cause structural damage. Skis frozen solidly to the ground should be freed by other methods such as by using a shovel, pick, etc.

126. Landing

Landing in loose snow is extremely hazardous, especially when no reference points are available.

a. When practicable, it is advisable to land near existing markers that will assist in depth perception; e.g., fences, buildings, vehicles, rocks, or trees. If suitable breaks in the snow are not available, one or more markers may be dropped (a pine branch or small tree, weighted colored cloth, or smoke grenade). An aid to depth perception is particularly important on new snow and with overcast sky conditions.

b. Because visibility will be obscured due to blowing snow caused by rotorwash, all approaches should be made to the ground. This type of approach minimizes the visibility restriction from blowing snow. Using a normal or night landing type approach with helicopters will result in improved visibility during touchdown. No unusual problems exist on landing with skis. Normal approach and landing procedures apply. When landing on any snow-covered surface, the approach should be planed to the ground to minimize possible whiteout conditions. When the

snow is not known to be hard packed, a zero speed no hover landing should be made. When the snow is known to be very hard packed, ski-equipped helicopter may make a slightly shallow approach and running landing. The snow cloud will remain behind the cockpit until contact is made with the surface. The lower power required in the running landing also results in a smaller snow cloud. Running landings and touchdown autorotations for practice should be practiced on snow or sod areas to reduce wear on the skis. Asphalt or cement areas should be avoided when practicing running type landings. Caution should also be exercised when landing in rocky areas as cracking of the fiberglass will reduce the life of the skis. During the touchdown portion of a running landing or autorotation, the heels of the skis will make contact first. A small amount of aft cyclic may be necessary to allow the front part of the skis to settle to the ground slowly and prevent the helicopter from bouncing to a nose-low attitude.

c. If not equipped with skis, the approach should be normal and constant in all respects, including a constant rate of deceleration (i.e., the "ideal" normal approach). As the snow cloud begins to obscure vision (15 to 30 feet above ground line), a switch is made to instruments, with emphasis on deceleration and use of collective pitch to touchdown. Under no circumstances should a hover be attempted. The helicopter will usually land with a firm and positive contact. If a previous ground reconnaissance has not been possible, a degree of risk (commensurate with the mission) must be accepted; as buried rocks or stumps could cause damage to the underside of the helicopter. If time permits, a number of "dry" approaches can be made with each approach blowing some of the loose snow away. Sometimes the only way to land under loose snow conditions is to slowly descend vertically from a high hover. If the descent is slow enough, the rotor wash will blow clear a touchdown point and visibility should not be a problem. Many occasions will arise where loose snow conditions are such that the dangers do not warrant the risk and the proposed landing site must be re-located.

127. Unloading Troops in Deep Snow

If the helicopter is to remain with the troops, they should not disembark until the rotors have stopped moving. However, if the helicopter is to take off immediately, then time and safety become primary considerations. A recommended procedure is for the troops to throw their equipment from the helicopter, disembark, and then lie on top of all loose equipment. (It is much safer for the troops to remain under the rotors until the helicopter has lifted off than it is to grope around for the equipment under

the low ground clearance of the rotors.) Personnel within the radius of rotor wash must protect their faces by turning away from the main blast and pulling the parka hood over their heads and faces. After the helicopter departs, individuals should check each other for frostbite. Without skis, the UH-1D/H helicopter—

a. Will normally come to rest on the bottom of the fuselage with the snow about level with the helicopter floor.

b. May sink in the snow approximately 61 centimeters (2 ft), reducing the normal 236 centimeters (7 ft 9 in.) main rotor blade clearance to approximately 152 centimeters (5 ft). Then passengers depart or approach the helicopter only when cleared by the crew chief and avoid walking forward or aft.

128. Ground Handling

Skis are designed with a cutaway portion for the ground handling wheels to be installed without removing the skis. Also, a cutaway portion on the front of the skis allows for installing the tow bar.

129. Maintenance

Current types of fiberglass skis for skid-equipped aircraft present few maintenance problems. Heavy-duty fiberglass repair kits may be used for most damaged areas of the skis. After every 100 hours of operation, after extended periods of running landings or autorotations, or during periodic inspections, the helicopter should be jacked up and the steel runners should be inspected for wear.

APPENDIX A

REFERENCES

Grateful acknowledgement is made to The Canadian Army; The Canadian Department of Transport; the De Havilland Aircraft of Canada, Limited, Downsview, Ontario; Edo Commercial Corporation, 65 Marcus Drive—Melville, New York 11746; and to Petroleum Helicopters Inc., P.O. Box T, Lafayette, Louisiana 70501, for their assistance in furnishing certain reference material in this manual without charge.

1. Army Regulations (AR)

95-1	Army Aviation—General Provisions and Flight Regulations.
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2. Field Manuals (FM)

1-100	Army Aviation Utilization.
1-105	Army Aviation Techniques and Procedures.
5-36	Route Reconnaissance and Classification.
20-151/OPNAVINST 3730.4A/AFM 64-6/ CG-306	Aircraft Emergency Procedures Over Water.
31-70	Basic Cold Weather Manual.
31-71	Northern Operations.

3. Technical Manuals (TM)

1-1-1-641	Minimum Equipment Requirements for Over-Water, Arctic, and Desert-Tropic Flights.
1-260	Rotary Wing Flight.
55-series-10	(Appropriate Aircraft Operator's Manuals).
55-series-20	(Appropriate Aircraft Organizational Maintenance Manuals).
55-501	Marine Crewman's Handbook.
55-1500-204-25/1	General Aircraft Maintenance Manual.

4. Department of the Army Pamphlets (DA Pam)

310-6	Index of Supply Catalogs and Supply Manuals (excluding types 7, 8 and 9).
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5. United States Coast Guard Publications (CG)

169	Rules of the Road—International and Inland.
172	Rules of the Road—Great Lakes.
193	Aids to Marine Navigation of the United States.

Coast Guard publications may be obtained upon request from Coast Guard Marine Inspection Offices, the major ports, or from the Commandant, United States Coast Guard, Washington, D.C. 20591.

APPENDIX B

OPEN SEA EVALUATION AND FLOATPLANE EMERGENCY LANDINGS

1. General

If an open-sea landing cannot be avoided, the approach should be preceded by thorough reconnoitering. The sea usually heaves in a complicated criss-cross pattern system of swells of various magnitudes, overlaid by whatever chop the wind is producing. A relatively smooth spot may be found where the cross swells are less turbulent. Both a high and a low reconnaissance are necessary for accurate evaluation of the primary and secondary swell systems.

2. Definitions

Before discussing sea evaluation, some basic definitions of oceanographic terminology are necessary. They are—

a. Fetch. The distance the waves have been driven by a wind blowing in a constant direction without obstruction.

b. Sea. The condition of the surface that is the result of both waves and swells.

c. Swell. The condition of the sea surface which has been caused by a distant disturbance. The individual swell appears to be regular and smooth with considerable distance between the rounded crests.

d. Primary Swell. The swell system having the greatest height from trough to crest.

e. Secondary Swells. Those swell systems of less height than the primary swell.

f. Swell Direction. The direction from which a swell is moving. This direction is not necessarily the

result of the wind present at the scene. The swell encountered may be moving into or across the local wind. Swells, once set in motion, tend to maintain their original direction for as long as they continue in deep water, regardless of changes in wind direction.

g. Swell Face. The side of the swell toward the observer. The backside is the side away from the observer. These definitions apply regardless of the direction of swell movement.

h. Swell Length. The horizontal distance between successive crests (para 4a(3)(e)).

i. Swell Period. The time interval between the passage of two successive crests at the same spot in the water, measured in seconds.

j. Swell Velocity. The velocity with which the swell advances with relation to a fixed reference point, measured in knots. (There is little movement of water in the horizontal direction. Each water particle transmits energy to its neighbor, resulting primarily in a vertical motion, similar to the motion observed when shaking out a carpet.)

k. Wave (or chop). The condition of the surface caused by local winds. It is characterized by its irregularity, short distance between crests, whitecaps, and breaking motion.

3. Sea State Evaluation

a. Sea State Condition Number. To estimate sea state condition by number, see table 7.

Table 7. Sea State Condition Number

Sea state condition number	Sea state description	Wind description	Average wind velocity (knots)	Average wave height	
				(meters)	(feet)
0	CALM. (Smooth and mirrorlike).....	Calm.....	Less than 1.	0	0
1	SMOOTH. (Ripples with scalelike appearance. No foam crests.)....	Light air.....	2	0	0
2	SLIGHT. (Small wavelets with crests of glassy appearance—not breaking.).....	Light breeze.....	5	0.3	1
3	SLIGHT. (Large wavelets with some crests beginning to break.).....	Gentle breeze.....	9	0.7	2
4	MODERATE. (Small waves, becoming longer. Numerous white foam crests.).....	Moderate breeze.....	14	1.2	4
5	ROUGH. (Moderate waves having a long appearance. Many white foam crests and some spray.).....	Fresh breeze.....	18	2	7
6	VERY ROUGH. (Large waves begin to form. White foam crests are more extensive everywhere. There may be some spray.).....	Strong breeze.....	22	3	10
7	HIGH. (Sea heaps up and white foam from breaking waves begins to be blown in streaks along the direction of the wind.).....	Near gale.....	30	5	16

b. Swells. Fetch, wind velocity, and the size of the body of water over which the wind has been blowing, determine the horizontal distance between swell crests. For example, on the Gulf of Mexico, wave height might be 20 feet while distance between crests might be 400 feet. The resulting height-to-length ratio would then be 1 to 20. If the crosswind is not too high, this height-to-length ratio may not be critical to capsizing. However, on a small lake, a wave height of 15 feet with distance of 150 feet between crests results in a height-to-length ratio of 1 to 10. This higher ratio may indeed be critical to capsizing, especially if the wave is breaking abeam of the floatplane. As the wave length decreases, wave height becomes increasingly critical to capsizing. Thus, when a high wave height-to-length ratio exists, a crosswind takeoff or landing should not be attempted as there is a danger of capsizing. With moderate wind velocities, downwind takeoff and landing may be downswell. However, downwind landing should never be attempted when wind velocities are high.

(1) When two swell systems are in phase, the waves act together and result in higher waves (fig. 22).

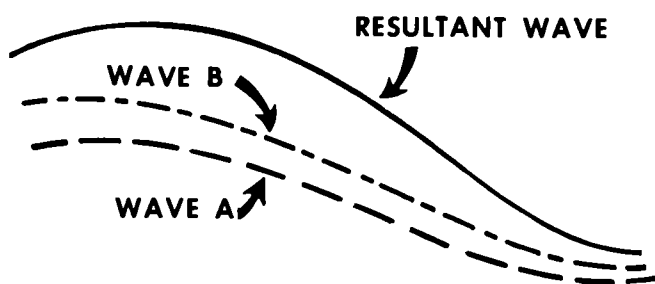


Figure 22. Two waves in phase.

(2) When two swell systems are in opposition, the resultant waves tend to cancel each other or "fill in the troughs" (fig. 23). This provides a relatively flat area that appears as a lesser concentration of whitecaps and shadows. It is a good touchdown spot for landing.

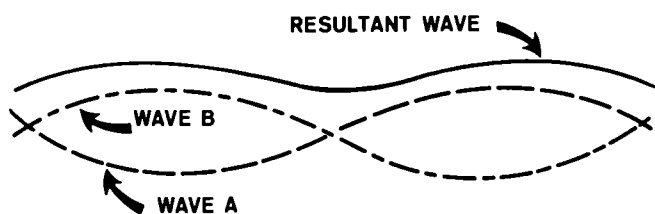


Figure 23. Two waves in opposition.

4. Swell System Evaluation

a. High Reconnaissance.

(1) Start at an altitude of between 1,500 and 2,000 feet, fly the floatplane straight and level, and observe the surface for swells. This should be done through a complete 360° pattern, rolling out approximately every 45°.

(2) When a swell is observed, fly parallel to it and note the heading, the direction of movement of the swell, and the direction of the wind.

(3) To determine the time and distance between swells, and their velocity, proceed as follows:

(a) Drop a smoke bomb or a float light and observe the wind condition from it.

(b) Time and count the passage of the smoke bomb or float light over successive crests. The number of swells will be the number of crests counted minus one. (A complete swell runs from crest to crest. Since the timing was started with a crest and ended with a crest, there is one less swell than crests.) Time and count each swell system.

(c) Obtain the swell period by dividing the time in seconds by the number of swells counted. For example, 6 crests were counted in 30 seconds (minus 1 crest equals 5 swells)—

$$\text{Swell period} = \frac{\text{Time in seconds}}{\text{Number of swells counted}} = \frac{30 \text{ seconds}}{5 \text{ swells}} = 6 \text{ seconds.}$$

(d) Determine velocity of the swell in knots by the formula—

Velocity = 3 knots × period in seconds. Using 6-second period—

$$\text{Velocity} = 3 \text{ knots} \times 6 = 18 \text{ knots.}$$

(e) Determine the distance between crests.

1. To determine the distance between crests in feet, multiply the square of the period by 5. For example, using a 6-second period—

$$\text{Length in feet} = 6^2 \times 5 = 180 \text{ feet.}$$

2. To determine the distance between crests in meters, multiply the square of the period by 1.524. For example, using a 6-second period—

$$\text{Length in meters} = 6^2 \times 1.524 = 55 \text{ meters.}$$

b. Low Reconnaissance. Descend to 500 feet and again observe the surface for swells and obtain a more accurate estimate of wind direction and velocity.

(1) Note the direction of the swell and see if it agrees with that obtained at 2,000 feet. If not, there are two swell systems from different directions. Often the secondary swell system is from the same direction

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as the wind. The secondary swell system may be superimposed on the first and come from the same direction. This condition may be indicated by the presence of periodic groups of larger-than-average swells.

(2) Determine wind direction from the smoke bomb or from foam patches on the sea. Whitecaps fall forward with the wind but are overrun by the waves. Thus, the foam patches will appear to slide backward into the direction from which the wind is blowing.

(3) Estimate wind velocity by noting the appearance of the whitecaps, foam, and wind streaks. To estimate wind velocity from sea surface indications, see table 8.

Table 8. Wind and Sea Prediction Chart

Wind velocity (knots)	Normal wave height		Sea condition
	(meters)	(feet)	
0	0	0	Smooth, slick sea.
2	0	0	Small, occasional ripples.
3-4	0.2	0.5	Small ripples all over—no calm areas.
5-6	0.3	1	Well-defined waves—smooth with no breaking.
7-9	0.6	2	Occasional whitecaps.
10-11	0.9	3	Pronounced waves, frequent whitecaps which carry a short distance.
12-13	1.2	4	Whitecaps close together, carrying over a distance equal to the wave height; slight traces of wind streaks.
14-16	1.5	5	Clearly defined wind streaks whose lengths are becoming equal to about 10 wave lengths; light flurry patches.
17-19	2	7-8	Long, well-defined streaks coming from same direction as wind; many whitecaps.
20-22	3	9-10	Streaks are long and straight; whitecaps on every crest; wind picks up and carries mist along; large waves.
23-26	4	11-14	Large seas with waves forming on them; wind picks up and carries occasional wave crests.
27-30	5	15-21	Heavy seas; pronounced white streaks; wind picks up frequent wave crests and carries along; breaking, rolling waves are forming.
31-35	7	23	Continued rolling waves, wind carries all wave crests for a distance equal to one and one-half wave lengths, suds and foam streaks.
36-43	8	25-30	Well-defined foam on the heavy seas, suds and foam streaks; waves and seas breaking and rolling.

c. *Select Landing Heading.* Chart all observed variables on a slip of paper and select the most probable heading or headings. Descend to 100 feet and make a final evaluation.

(1) Fly on various headings and note on which heading the sea appears most favorable. If the heading which looks smoothest corresponds with one of the possible headings selected by other criteria (para 5-9), it should be selected over the others.

Warning: Caution must be exercised in making a decision based on the appearance of the sea. Often a flightpath directly downswell will appear to be the smoothest, but a landing on this heading could be disastrous.

(2) Look for any glare on the water which could be a deterrent to visibility during a landing.

d. *Select Landing Area.* After selecting the heading and on final approach, select the landing area by looking ahead for unusually rough areas and try to avoid them. Look for a relatively smooth area and try to set down on the near edge.

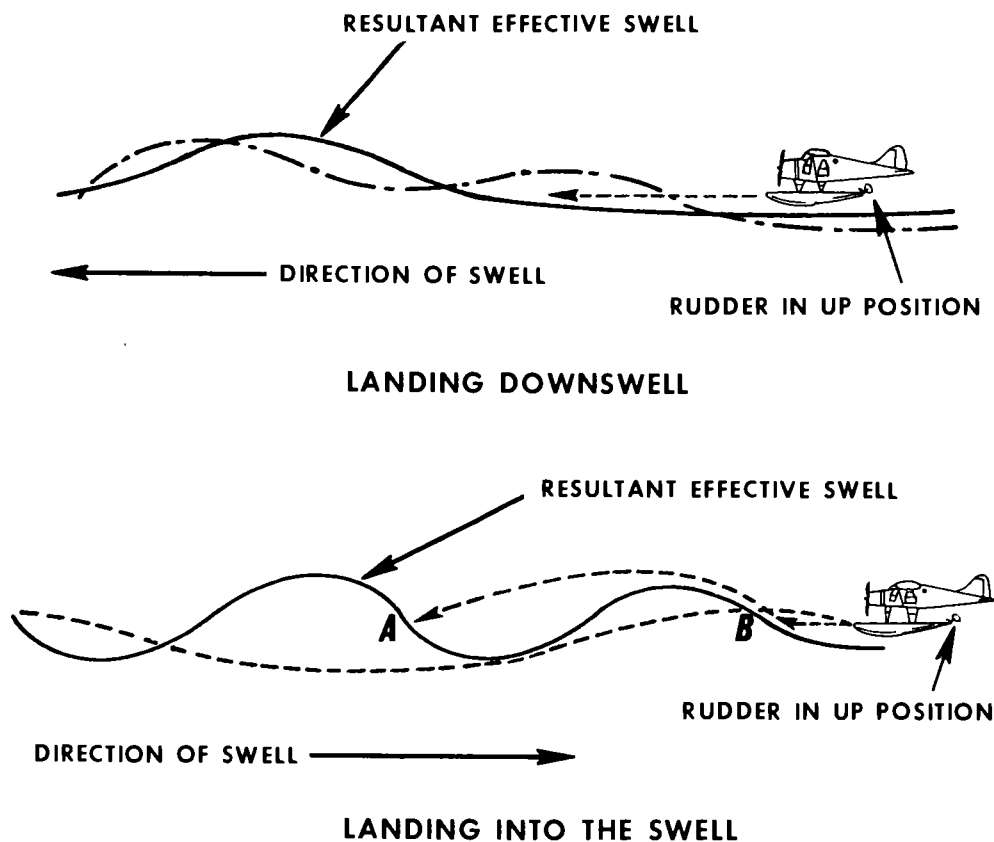
Caution: If low ceilings prevent complete sea evaluation from the altitudes prescribed above, any open-sea landing should be considered calculated risk, as a dangerous but unobservable swell system may be present in the proposed landing area. Descent and before landing checklists should be accomplished prior to descending below 1,000 feet during open-sea evaluation.

5. Landing Downswell

Landing downswell is best. To compare landing downswell and landing into the swell (fig 24), assume a 10-second swell period. Length of swell is 500 feet with a velocity of 30 knots or 50 feet per second (para 4a(3)). Assume the floatplane takes 890 feet and 5 seconds runout time to come to rest.

a. *Downswell Landing.* The swell is moving with the floatplane during the landing runout, thereby increasing the effective swell length by about 150 feet and resulting in an effective swell length of 650 feet. If the floatplane is touched down just beyond the crest, it will come to rest about 240 feet beyond the next crest.

b. *Landing Into the Swell.* During the 5 seconds of runout, the incoming swell moves toward the floatplane a distance of about 150 feet, thereby shortening the effective swell length to about 350 feet. Since the floatplane takes 890 feet to come to rest, it would meet the oncoming swell before halfway through its runout (B, fig 24) and it would probably be thrown into the air out of control (A, fig 24). This landing heading is to be avoided if at all possible.



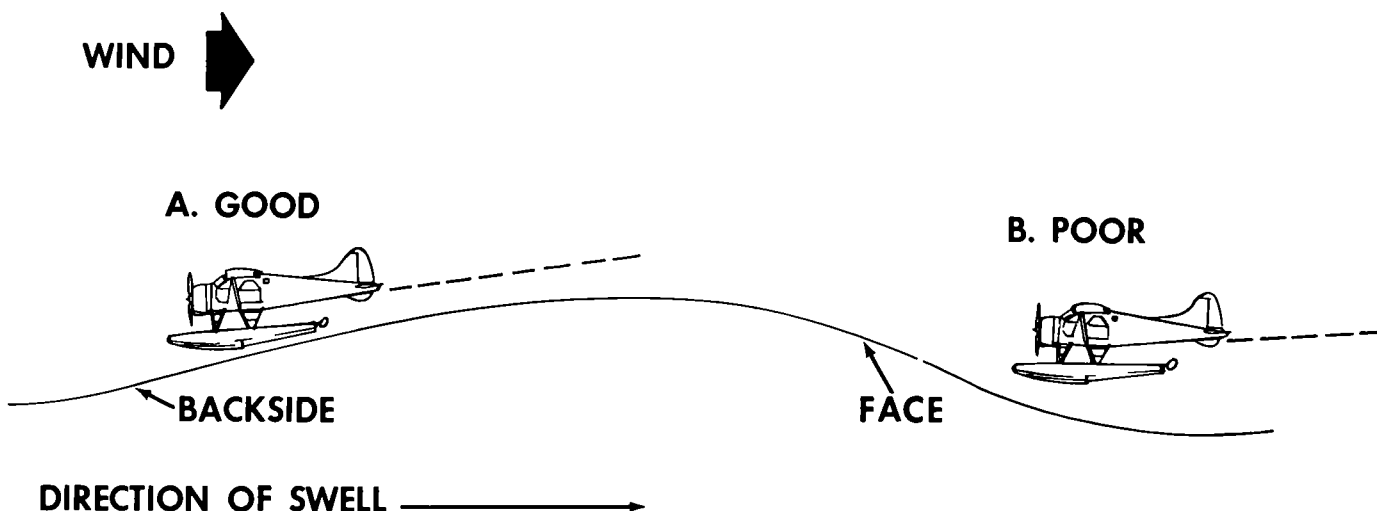
aavn1088

Figure 24. Landing downswell increases effective swell length.

6. Landing Parallel With the Swell

Landing parallel with the major swell system is the best landing heading. In this type landing, it makes little difference whether touchdown is on top of the crest or in the trough. It is preferable, if pos-

sible, to land into a headwind on the backside of the swell (A, fig 25), not on the face of the swell (B, fig 25). If only one swell system exists, the landing problem is relatively simple—even with a high, fast system.



aavn1089

Figure 25. Landing on the face and back of a swell into a 15-knot headwind.

7. Landing With More Than One Swell System

Most floatplane landings on the open sea involve two or more swell systems running in different directions. With many systems present, the sea presents a confused appearance. When the secondary swell system is from the same direction as the wind, the landing may be made parallel to the primary system with the wind and the secondary system at an angle. There is a choice of two headings paralleling the primary system. One heading is downwind and down the secondary swell; the other is into the wind and into the secondary swell. The choice of heading will depend on the velocity of the wind versus the velocity and the height of the secondary swell.

8. Effect of Chop

Local winds create chop (waves) which act much the same as a swell system. When winds are 14 knots or above, chop rides on top of the resultant uneven surface and, if severe, may serve to hide the underlying swell systems. Moderate chop, alone, can be discounted as a danger to landing.

9. Effect of Surface Wind

The best condition for an open sea landing is one which permits landing parallel to a single swell system and into the wind; this situation seldom exists. Some crosswind is usually present, and must be accepted in order to parallel the major swell. Two headings parallel to the major swell will be possible. Select the heading which has greatest headwind component (A, fig 26). However, if a pronounced secondary swell exists, it may be desirable to land down the secondary system and accept some tailwind component (B, fig 26).

Caution: Due to the rough sea state, landings should not be attempted in winds greater than 25 knots except in extreme emergencies. Crosswind limitations for each type of floatplane must be the governing factor in crosswind landings.

10. Sea Evaluation at Night

To select a suitable landing heading, a pilot must know the sea and wind conditions. If an emergency occurs shortly after nightfall, he may be able to select a heading based on an estimate of conditions observed during daylight. Often he will have no conception of the sea condition. The information must be obtained from other sources, or by flare illumination or moonlight. If near a ship, sea weather conditions and a recommended landing heading may be obtained from the ship. A landing heading based on such information, however, is subject to error and should only be used as a last resort. It is better for a pilot to evaluate the sea himself. He can accomplish this by executing

the teardrop pattern (fig 27) of night sea evaluation as follows:

a. Set parachute flare and adjust altitude so that flare will ignite at 1,700 feet. Altitude should be as close to 2,000 feet as possible.

b. After drop, adjust altitude to 2,000 feet and maintain heading for 45 seconds.

c. Turn back 220° , left or right, until the flare is almost dead ahead. The sea becomes visible after the first 70° of the turn is completed, allowing approximately 90 seconds for sea evaluation. Use standard rate turn (3° per second).

d. Immediately after passing the flare, if it is still burning, the pilot may circle to make additional evaluation during remaining burning time.

Note. If both pilot and copilot are present, the pilot should fly the floatplane and the copilot should concentrate on the sea evaluation. A few flares fail to ignite. If only two flares are available and sea conditions are known or believed to be moderate, it may be advisable to dispense with the sea evaluation and use both flares for landing (para 11a).

11. Night Emergency Landing

a. *Landing by Parachute Flare* (fig 28). After selecting a landing heading, a landing should be made as follows:

(1) Make all preparations for landing. Complete cockpit check.

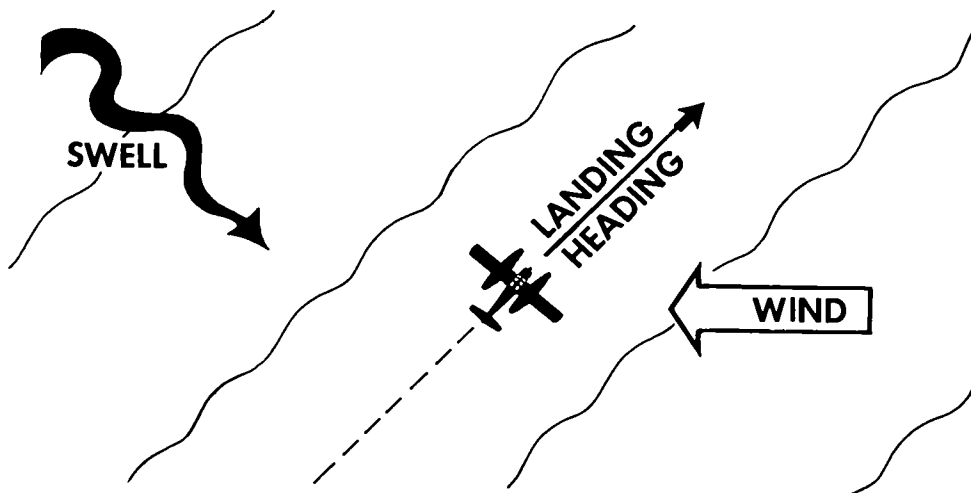
(2) Take up a heading 140° off the selected landing heading. Lower flaps and reduce to desired landing pattern approach speed.

(3) Set parachute flare and adjust altitude so that flare will ignite at 1,700 feet. Altitude should be as close to 2,000 feet as possible.

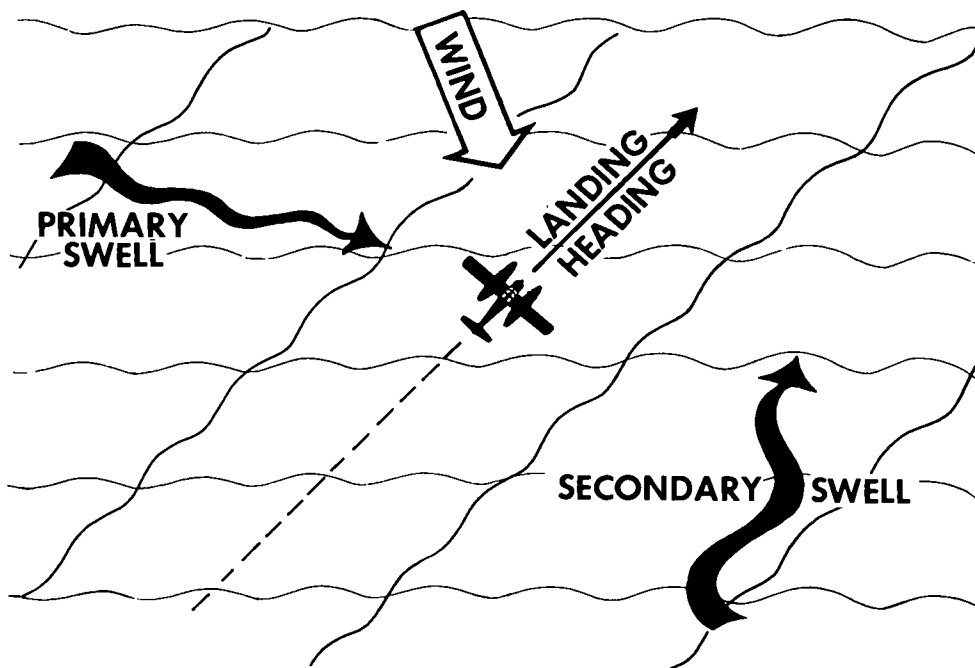
(4) After flare drop, begin a rate of descent of 1,000 to 1,500 feet per minute. Use the higher rate if initial altitude is above 2,000 feet. Maintain heading for 45 seconds.

(5) After 45 seconds, make a standard rate turn (3° per second) toward the reciprocal of the landing heading. Continue turn until flare is dead ahead. During this turn, adjust rate of descent so as to roll out of turn at an altitude of about 200 feet. During the last two-thirds of the turn the water will be clearly visible, and the floatplane can be controlled by visual reference.

(6) When out of the turn with the flare dead ahead, the floatplane will be on the proper landing heading. Land straight ahead using the light of the flare. *Do not overshoot.* The best touchdown point is several hundred yards short of the flare. A rapid descent in the early stages of the approach allows a slow rate of descent when near the water. This should prevent flying into the water at a high rate of descent due to faulty depth perception or altimeter setting.



A. SINGLE SWELL SYSTEM



B. DOUBLE SWELL SYSTEM

aavn1193

Figure 26. 15-knot crosswind landing headings.

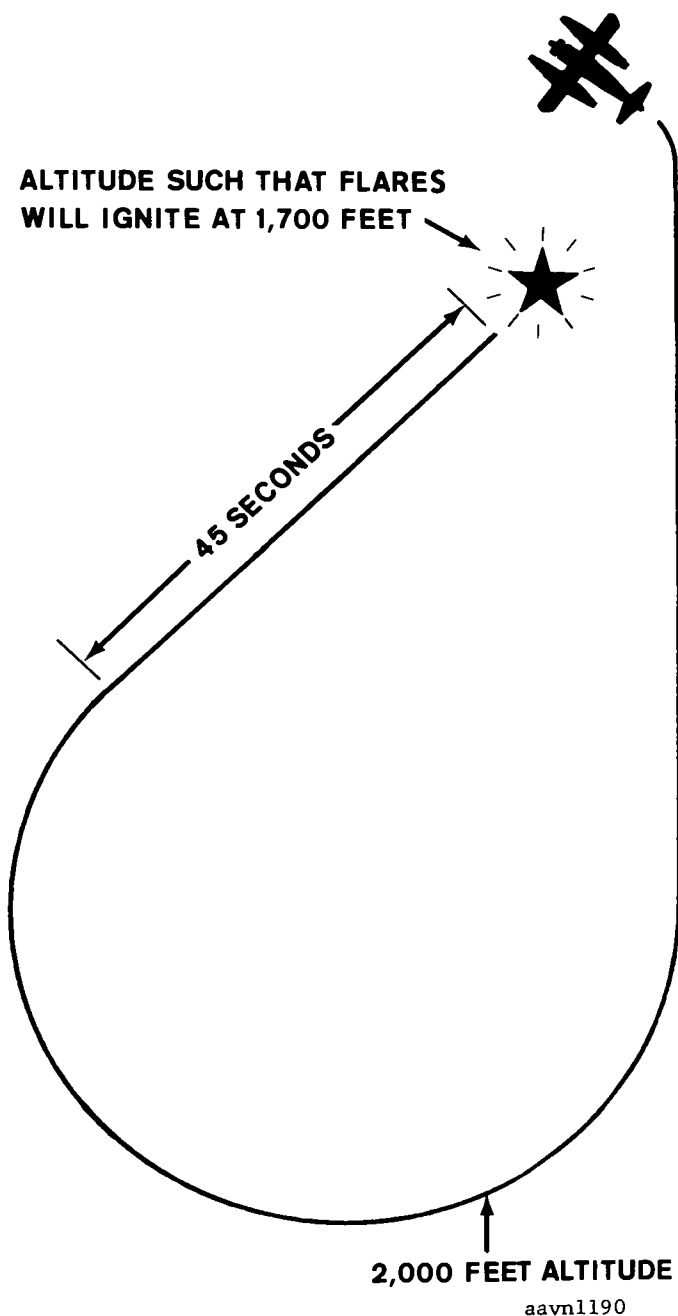


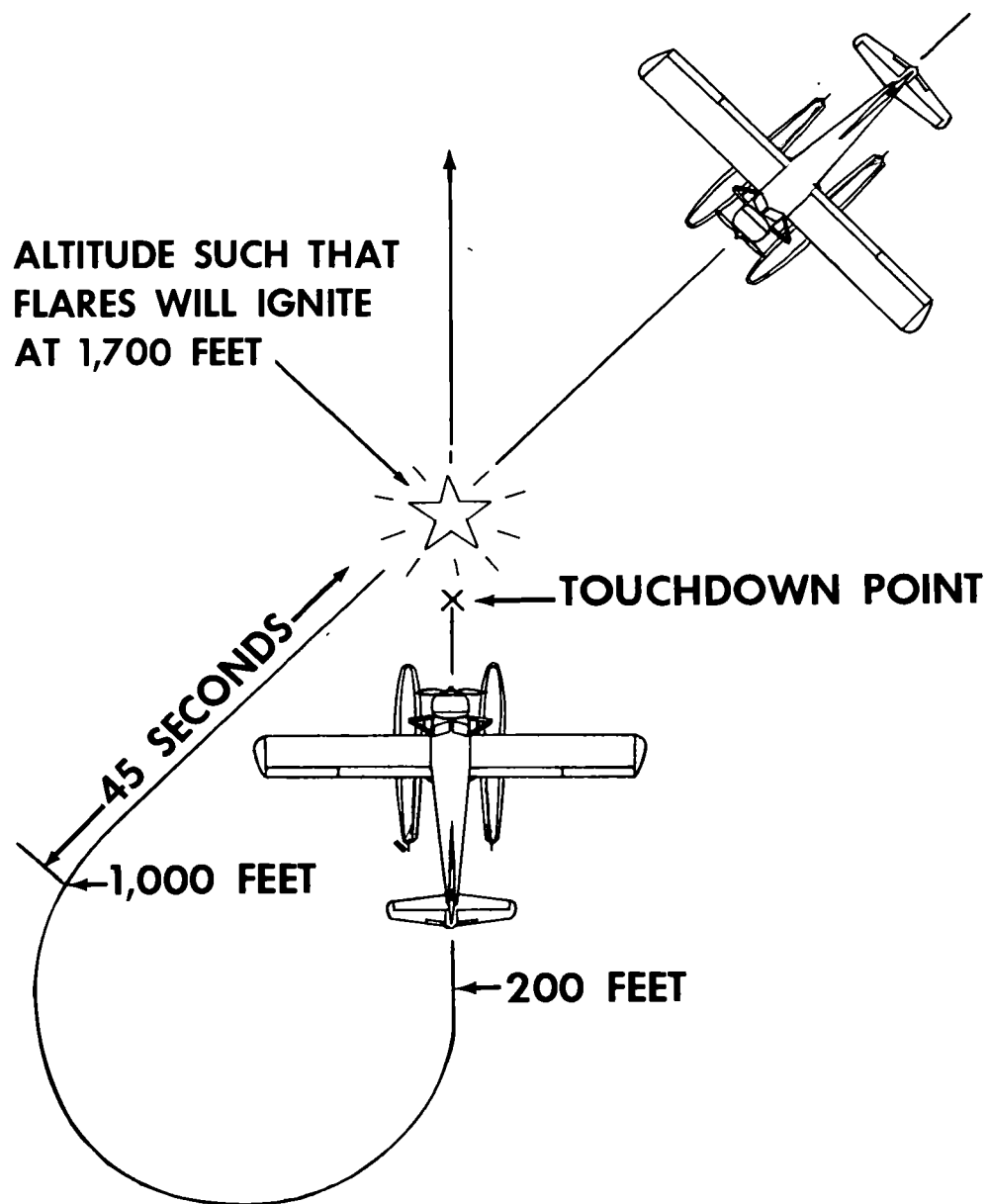
Figure 27. Teardrop pattern of night sea evaluation.

b. Landing Without Parachute Flares. If the floatplane has no flares but does have a supply of drift signals or smoke floats, the landing can be made easier by dropping a line of such floats on the landing heading at 2-second intervals. Up to 20 such markers may be profitably used. The line of markers may be used in the same manner as runway or seadrome lights. They serve as an approach line, and aid in depth perception. These open-flame markers are a slight fire hazard. Landing lights should not be used on final approach. Unless considerable whitecaps are present, the use of landing lights may cause a false depth perception sense, and may cause a pilot to level off high or to fly into the water. When landing without parachute flares at night, a power approach should be made. A power attitude should be set up for a rate of descent of 200 feet per minute and an airspeed from 10 to 20 percent above stall speed with flaps down. This approach should be maintained until the floatplane makes contact with the water.

12. Emergency Landing Under Instrument Conditions

a. When surface visibility is zero, the pilot has no alternative but to fly the floatplane onto the water by instruments. If flying at lower altitudes, the surface wind conditions can sometimes be estimated from navigational data. An estimate of the wind and sea state and a recommended landing heading may be available via the air-ground station. Forecasts obtained in this manner or prior to departure may have to be relied on as the best information available to determine a landing heading. To alleviate the possibility of an altitude error during the approach, the latest altimeter setting should be obtained for the area selected for landing.

b. When a landing heading is decided upon, a power approach should be made. A power attitude should be set up for a rate of descent of 200 feet per minute and an airspeed 10 to 20 percent above stall speed with flaps down. This approach should be maintained until the floatplane makes contact with the water, or until visual contact is established.



aavn1192

Figure 28. Night landing pattern using parachute flare illumination.

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U.S. MARINE NAVIGATION AIDS

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FLOATPLANE OPERATIONS BASIC PRINCIPLES

FLOATPLANE TAKEOFFS

FLOATPLANE LANDINGS

SEAPLANE BASE FACILITIES

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